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A New Automatic Screw Machine.

We are enabled to present herewith engravings of an automatic screw machine, regarding which nothing has been heretofore published, though the machine has for some time been attracting attention among mechanics who appreciate the significance of its operations. This machine makes all kinds of machine screws within its capacity from the coil of wire, and finishes them, including the slot in the head; delivers them to a wire receptacle at the side of the machine, separate from the oil and chips, and works entirely automatically.

In its general form it will be seen to resemble the automatic machine now in general use, but differs radically in its method of operation, since the wire does not revolve, but is held stationary, while the tools revolve around it.

The coil of wire is placed upon a suitable reel at the left of the machine, and first passes through a straightener of the usual form, and then to a head *A*, Fig. 1, in which it is gripped by a chuck, and held, while the operations of reducing to size, threading, finishing the head, and cutting off are performed.

A drawing of the head *A* is seen at Figs. 2 and 3. In the latter figure *A* is the upright attached to the bed which supports the working parts of the head. To this is secured, by the nut shown at the right, a quill which is stationary and has fitted to it internally the split draw chuck shown, and externally, another sleeve which is driven by the spur gear wheel *B*, which gives this sleeve and the flanged head *C* the required rotary motion. Upon the face of *C*, and inside the flange (at the left of Fig. 3) are two small tool slides which are placed diametrically opposite each other. One of these slides carries the tool which forms the head of the screw while the other cuts off, and they are fed inwards towards the wire by means of a cam *D* (Fig. 3) which, when not in action, revolves uniformly with the plate *C*, carrying with it the diagonally slotted sleeve *E*, which is really part of this cam. Fitted over the sleeve *E* is a ring *F*, which revolves with the other parts, being driven by the two bolts *a a*, Fig. 2, which pass through the gear *B* and ring *F*, and are tapped into the plate *C*. But the ring *F* can be given an endwise movement upon the sleeve *E* by means of the usual forked lever, as shown, and when given such movement, it imparts to sleeve *E* and cam *D* a rotary motion relative to the other parts, and thus moves the tools to and from the work at the proper times. The ring *F* imparts this motion by means of studs which engage with the diagonal slots in the hub *E*. It will be understood, of course, that though we have first described the construction and operation of this head, it does not operate, except to hold the wire until after the operations, yet to be described, have been performed, and the proper sequence of the operations is secured by the cam wheels on the shaft below the bed, which is driven by the large cone pulley at the left, and suitable

Fig. 2

Fig. 3

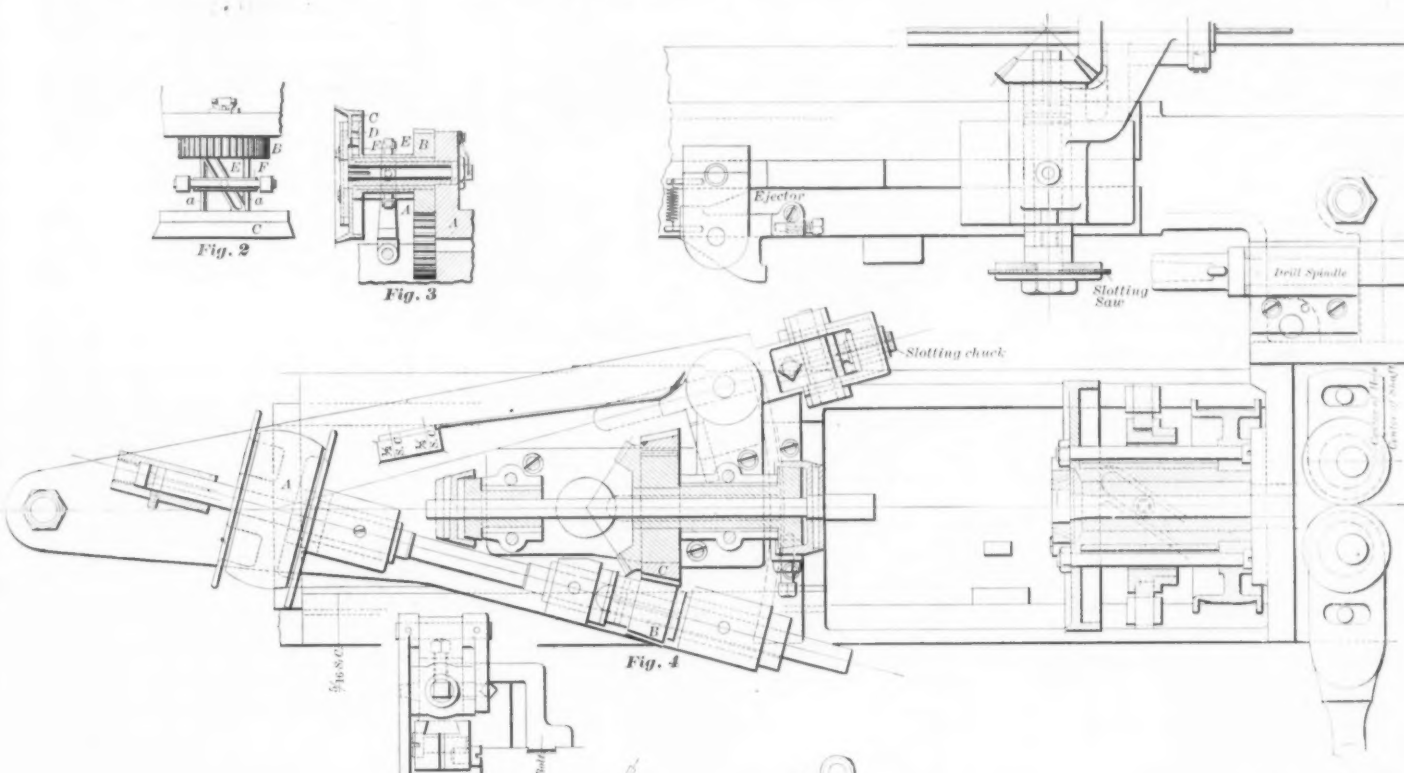


Fig. 4

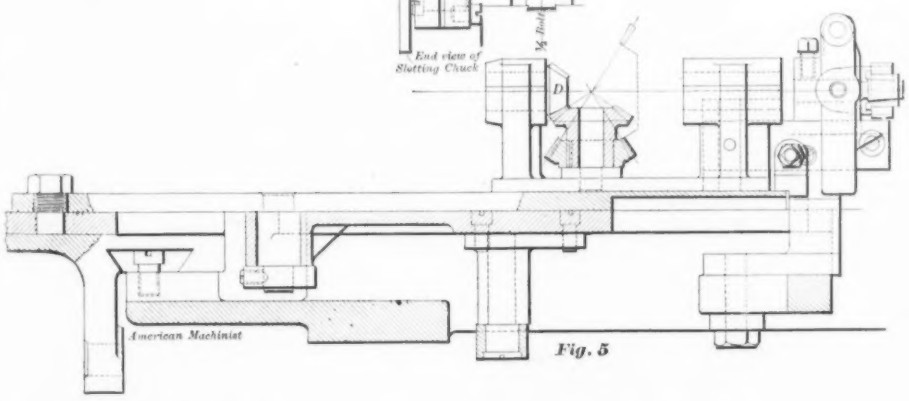
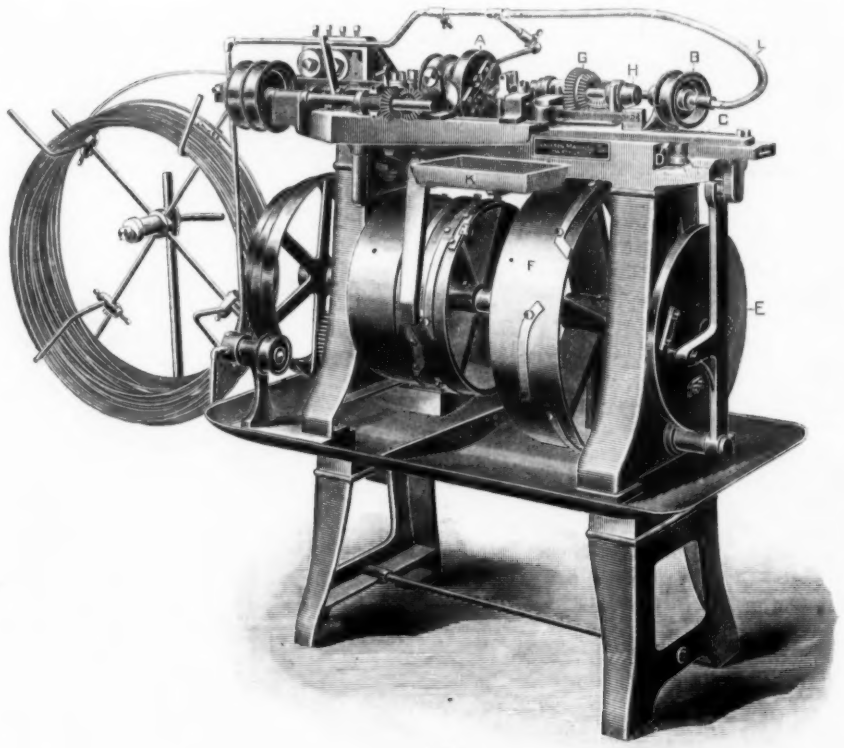


Fig. 5



A New Automatic Screw Machine.—Fig. 1.

pulley *A*, Fig. 4, which is directly connected to the spindle which carries the tool for reducing to size. When this tool has completed its cut and has been drawn back, the plate swings into the position shown by Fig. 4, where the spindle carrying the threading die is in working position. This spindle is driven by the bevel gears *B* and *C*, Fig. 4, which, however, do not drive it directly, but through the medium of friction clutches. The male portions of these clutches are upon sleeves, to which gears *C* (Fig. 4) and *D* (Fig. 5) are attached, the latter running at higher speed in the reverse direction for backing off the die. The movement of the spindle endwise engages or disengages these clutches and reduction gearing. There are two spindles opposite the head *A*, and they are mounted upon a plate which swings from side to side to bring the spindles successively into working position. This swinging of the plate is accomplished by the cam plate *E* (Fig.

controls the motion of the die. After the screw is threaded, the slotting chuck is brought into line with it, and, advancing, firmly grips the screw which is then cut off from the wire by the process previously described, and carried over into line with the slotting saw, the chuck being swung about a pivot at the same time, which brings the screw into line with the saw. After being slotted, the screw is thrown out by the ejector shown. This work is done at the same time that the next screw is being reduced to size, and therefore consumes no time.

In case the work demands it, a hole can be drilled in it instead of the slotting operation, this being accomplished by the drilling spindle shown at the right of the saw.

Oil is forced through the cutter spindle and is fed to the work during this operation in such a manner as to secure the best possible results.

The most fruitful source of noise in the ordinary screw machine is done away with in this because the wire does not revolve, and in fact the action of the machine is very quiet.

The machine is the invention of Mr. Edward E. Claussen, and is built by the Claussen Machine Screw Co., 370 Asylum street, Hartford, Conn.

The Shops of W. F. & John Barnes—I.

BY JOHN RANDOL.

Nothing is more interesting than the story of success achieved under unlikely circumstances, and the detail of lives which owe nothing to surroundings, and win all the desirable things through the exercise of those natural powers which are born with the individual.

In this light the careers of the Barnes Brothers, the widely known makers of a peculiar class of light wood and ironworking machinery located at Rockford, Illinois, are at once romances and sermons; and I only regret that I must here touch so lightly and so briefly on the human side of their work, since the mechanical novelties produced by them which have never before been illustrated or described in print, are so many and so notable as to demand all of the space available here. The regular line of manufacture of the W. F. & J. Barnes Company is too well known to need special mention; their saws, lathes and drilling machines came at once into popular favor because of their low cost, small driving-power requirements, wide range of use, and very great producing powers, which in many cases have enabled their purchasers to pay for them out of the earnings from a few days use. All of these machines are marked by extreme simplicity and directness of invention, by the comparatively small labor needful for their construction, and consequent low cost, and by their very great convenience and general handiness and adaptability to various lines of work, by which mechanics with little or no capital may become their own employers, and reach individual business successes which would be wholly impossible without such tools as are furnished by these three brothers, who started in life with no money at all, and earned every dollar they had with the work of their own heads and hands, and began machine building on the farm, with the barn for a work shop, with no incentives or facilities outside of their own natural proclivities and abilities.

The brothers, John, William Fletcher, and Benjamin Franklin, were born at the homestead on their father's farm, in the township of Mt. Morris, in the valley of the Genesee, in York State. Their father was a carpenter as well as a farmer, and had a shop in the barn, which included a wood-turning lathe driven by a belt from the grindstone, instead of a treadle; and the one concern of his life for the future of his eldest son John, was to prevent the boy from frittering away his time tinkering in the barn, when he should have been exerting his muscles in useful effect on the soil of the farm. "About all the 'talkings to' my father ever gave me," said John Barnes in speaking of his early days, "were scoldings about tinkering in that shop."

At nineteen years of age, John took a serious look at the $12 a month as a farm hand, which was his rightful and natural inheritance, decided that the scene was not satisfactory, and cast about for means to better his prospects; the fall of 1853 he rented an old threshing machine, and during the threshing season he cleared $75 by its use. With $40 of the $75 he purchased this worn out threshing machine, and rebuilt it during the winter in his father's barn, much to the disgust of his thrifty parent, who saw in this work of his oldest son only a persistent tendency to "tinker," which boded ill for his success in life. With this rebuilt thresher, however, John cleared as much as $75 in one month, and the threshing season netted him quite a tidy sum. Between April and August, 1855, John, feeling himself a capitalist, built an entirely new threshing machine, from full-size drawings made in pencil on pine boards, in the barn, of course. This was a fine machine; the woodwork he made with his own hands; such metal work as he could not manage on the grindstone-driven lathe, he had done at a little machine shop at Silver Creek, or Wiscoy, not far distant; and the cylinder shaft was made of English tool steel, because he wanted it small and strong. John Barnes put the best he had of his young head and hands into the new threshing machine, and his best was pretty good. The machine was driven by a 10 horse sweep power, and soon after he began work with it in the season of 1855, when he was 22 years old, he threshed 640 bushels of wheat in one day, and the end of the threshing season found him a plutocrat with $500 in cash, net earnings, and all debts paid. In the winter of 1855–6 John built his third thresher, in which he rashly discarded all precedents, and introduced a "cylinder separator," which a short trial in the season of 1856 convinced him was not a success; so taking the 1855 machine he began his fall threshing, but soon found the wheat was all straw, the grain in the Genesee Valley that year being destroyed by wevil; he therefore drove his horses and machine to Buffalo, and with one man, took all to Chicago by steamer, and hooked up the traces and started west from that town, looking for threshing where there was wheat in the straw. He found his first job just south of Rockford, a hundred miles west of the City of the Lakes. Rockford was then a flourishing town of 6,000 inhabitants, and then, as now, in the midst of a fertile country, through which runs the beautiful Rock River. The thresher was highly appreciated; after working with it near Rockford a few weeks he sold the entire outfit, machine, horses and all, and returned to York State, to Geneseo. He built another thresher, and brought it west in the spring of 1857; sold it, and built another machine for a Mr. Champion. But the manufacture of threshing machines on any commercial scale demands a really large capital; the country was fertile and attractive to the farm bred mechanic, and for three years he raised wheat on rented ground, and put it in cribs, rather than to sell it for 40 cents a bushel. At the end of the third year wheat touched $1.06, and John sold out his holdings, and abandoned farm life, as it proved, for good. The broad prairie lands of the West opened up a new line of thought, and John proceeded to design and build a seeder, for sowing small grains by dropping, 25 feet in width, made to fold up to farm wagon width, when not operating. With this machine a man and pair of horses could evenly seed 80 acres in one day; about a hundred of them were built and sold, and one was in service as late as 1890. The seeders were put out in 1861, and John then took up the problem of the automatic rake for the reaping machine. The Grahams, builders of the J. H. Manny reaper, then in the hight of its popular favor, put out about five hundred of the Manny reapers with the Barnes rakes, which gave excellent satisfaction.

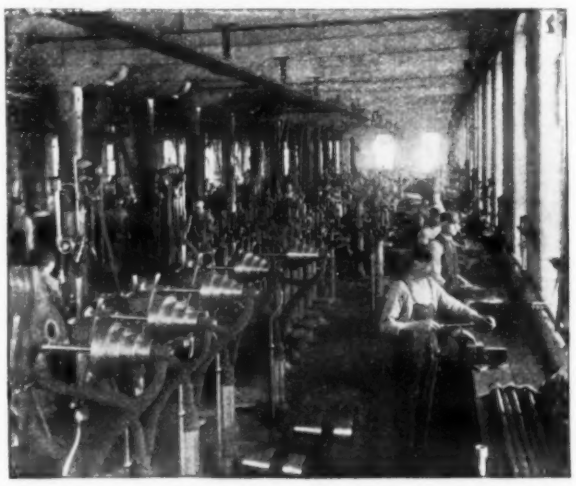


Fig. 1.

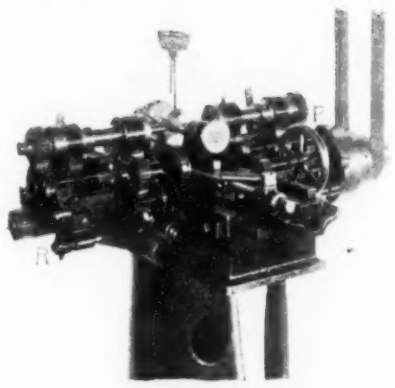
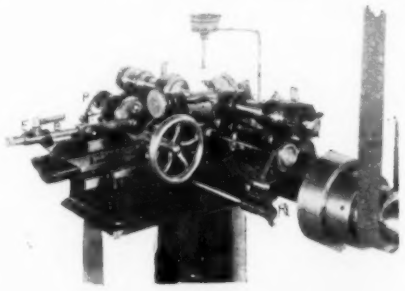


Fig. 3.



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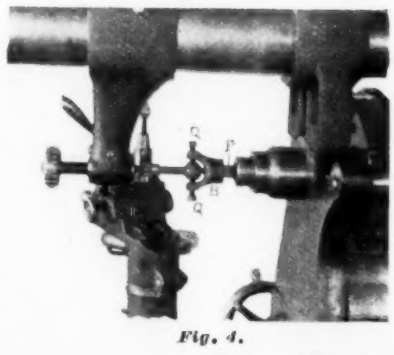


Fig. 4.

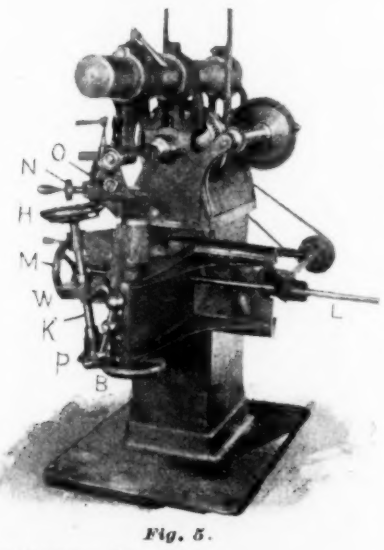


Fig. 5.

SPECIAL MACHINERY IN THE BARNES SHOPS.

In the meantime John's next younger brother, William Fletcher, had left the farm in his 20th year, and coming west to Rockford, worked for John on the seeders in the winter of 1860, and then went to work for Clark & Utter, machinists, in Rockford, and was with that concern for nearly four years, then going to the C., B. & Q. R. R. shops at Aurora, Illinois, where he ran the big wheel lathe, and built a model locomotive for the super in his spare hours, while he had cuts running.

The little engine pleased the head man so much that Fletcher was permitted to build an engine lathe for himself while the wheel lathe was turning locomotive drivers. This was a really elegant little tool, 6 inches swing, turning 12 inches between centers, back geared and screw cutting, with the back gears inside the cone, double and balanced, same as the Barnes Bros. now use in their well-known upright drill presses. With this toy lathe Fletcher returned to Rockford in the fall of 1868, and started a model shop. At that time the U. S. Patent Office demanded a working model of every mechanical invention on which application for patent was made, and model making was a flourishing industry. Fletcher made good wages in his own shop, where he was proprietor and all hands, and was soon joined by the youngest of the four brothers, Benjamin Franklin.

The elder Barnes had by this time sold the York State farm, and moved to Rockford, so that the whole family were now in the West.

Fletcher wanted a jig saw in his model shop, and built one so new, so still, so cheap and so effective that nearly every mechanic who came into his model shop wanted one; the essential feature of this jig saw, perhaps one of the most popular tools ever invented, was a peculiar friction clutch which Fletcher patented in 1871. The jig saw orders came in thick and fast, Fletcher and Frank found more help needed, John came into the combination to manage the sales and distribution, a small wood-turning lathe was added to the line of manufacture put out by the young firm of Barnes Brothers, other tools followed in rapid succession, business doubled about every three months, and the Barnes Brothers became an established factor of American tool making; still in their original line, reminiscent of the shop on the farm, with foot and hand-driven machines which the farmer's boy could purchase and use, and with which the "natural mechanic," untrained, could both train and support himself.

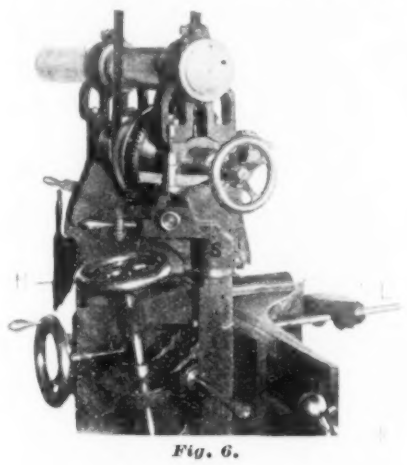
The Barnes Brothers became large and constant advertisers, and added to their list of tools for sale many of the machines in the way of drills and lathes which they had designed and constructed for their own use. All of these tools were marked by great simplicity of conception, low cost, and extreme handiness, and also by unusual combinations and expedients out of the accepted line of conventional machine tool design; and embodying innovations which, while perfectly adapted to the user's needs, and very largely bought from the first by individual users, were slowly recognized by owners of larger establishments. In speaking of this Fletcher said, "We paid for the first upright drill we ever owned $125. That was too much money for us at that time; we needed more drills, so we made a design of our own, not because we wanted to build drills, but because we wanted a cheaper machine than we could buy. Our 18-inch

upright cost us $125. We now sell a very much better 20-inch upright for less than half that money." Fig. 1, which is from a photograph of Barnes Bros.' drill erecting floor, April, 1895, shows 96 machines in progress, with the shop short-handed and on short time. This gives some idea of the favor with which the Barnes Brothers' work has finally come to be received by the regular machine shops. Speaking further, Fletcher Barnes said, "All of our tools have had entirely new features; all have had a thorough trial in our own service before being put on sale, so that we knew them to be thoroughly good before we offered them to the public. Yet their novelty and cheapness has always made them slow of sale at first. After they are once known, and the users find that they are really serviceable and durable as well as cheap and handy, the sales increase rapidly; and our doubting purchasers who buy in the first instance solely because of our low prices, end by becoming enthusiastic praisers and steady customers. Still the novelty of our work has always been against us, and we often think that life is too short to be spent in educating the public to use new devices, no matter how good they are. It is true we have a line of work which is our own, but to this day there are machine users who think our tools are cheap and queer. I myself often think we did a good deal of hard work which we need not have done, just because we wanted to give our customers tools which were both cheap and good."

As soon as the Barnes Brothers began to manufacture largely they, of course, designed many special tools, all of which were marked by the same extreme simplicity, and the same ability to produce new effects by unexpected and untried methods, which distinguishes all of their work. It is of these special tools and methods which are of a general adaptability that I propose to speak in detail here, as well as of a new engine lathe for manufacturing purposes, which, following their usual custom, the Barnes Brothers have had for years at work in their own shops without having sold one, and without giving it publicity by any method. Nothing shown here has ever been illustrated or described in print.

Among the earliest of the special tools made in this shop was a tool-post slotting machine, designed by Fletcher, entirely automatic in its action, and working simultaneously from both sides of the tool post, two cutting tools being employed. The drill slotter is a well-known tool (though it has never had a widely extended use in the United States), in which the drill has an end motion for feeding into the stock, this end motion being intermittent, and taking place at each end of the travel which causes the drill to cut a round-ended slot instead of a round hole. This travel may be imparted to the work or to the drill; in the machine shown in Figs. 2 and 3, this travel is given to the carriage which supports the tool post in process of slotting on a center at one end and in a three-jawed chuck at the other end. This work carriage has an adjustable-length reciprocating motion from the slotted disk crank *C*, connecting rod and round bar *B* adjustable in the bracket *E* to adjust the work table position. The shaft which carries the slotted carriage-driving crank has on its other end a short crank, which drives the rocker *R* carrying two pawl arms which drive the two feed screws which move the spindles in on the work. A hand wheel and pinion working a horizontal rack on the slide give a quick hand motion. The cutters are rosebits or end mills, with the teeth removed at the middle of the ends which enter the work. A stop action makes one mill stop and go back when the cutters approach to within about $\frac{1}{64}$ inch of each other, while the other goes on alone and cuts the slot entirely through. The collet driftway through the drill spindles is also cut on this little machine, which is an extremely well-arranged tool and capable of doing a large line of work expeditiously. It might be built on the same lines in much heavier forms than here shown and would then, of course, be equal to the common run of engine work. It is not patented, and contains many features not before combined in a drill-slotting machine, to my knowledge.

Figs. 4, 5 and 6 show a ball-handle and round wheel rim turning machine in the pillar and knee form, which might readily be applied, I should think, to any common pillar and knee milling machine. The crosshead or knee is bolted tight to the frame and has no vertical adjustment. The tool holding and guiding parts are a common tool post carried on a double slide with adjusting screws; this slide is carried on a dovetailed way on top of a horizontal arm having a hub *S*, which is bored to slip on the top end of a substantial vertical shaft and secured with a pinching screw. The lower end of this vertical shaft carries a large bevel gear *B*, driven by the pinion *P* to rotate the tool-carrying arm, either through the friction-secured hand wheel *H*, at the top of the hand shaft *K*, or by the worm gear inside the case *W*. This worm gear is driven by a worm on the horizontal shaft projecting to



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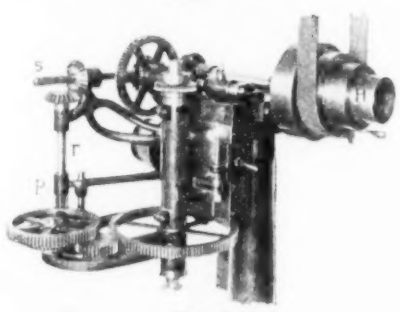

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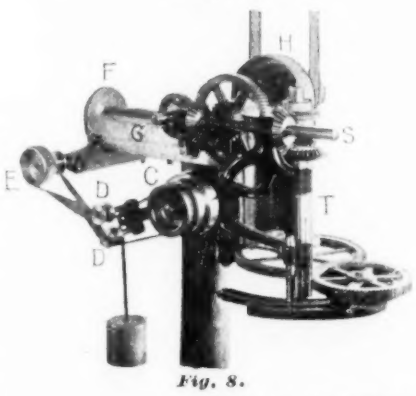

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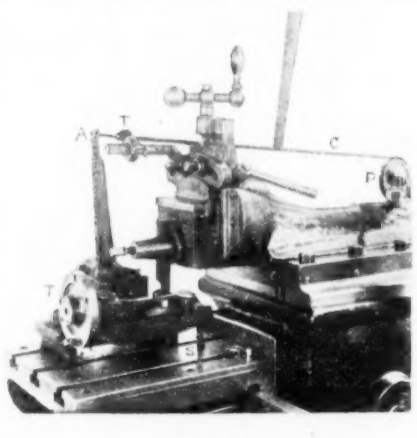


Fig. 9.

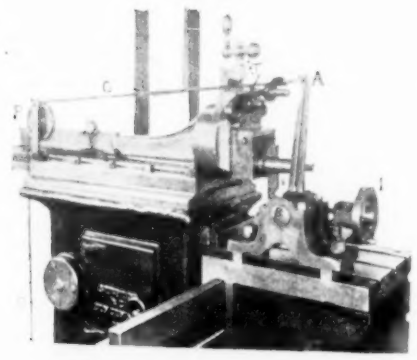


Fig. 10.

SPECIAL MACHINERY IN THE BARNES SHOPS.

the front in Figs. 5 and 6; the worm shaft is driven from *L* by a pair of miter gears not shown in the views given; the object of this arrangement being to get the universal in and out, up and down and crosswise tool post adjustments needed to bring the globe, or round cut path of the tool point in the correct relation to the work. The crank handle in front and the side hand wheel give the front and rear and crosswise adjustments rapidly, and the hand-adjusting screws *N* and *O* operate the tool post block on the swinging horizontal arm *S*.

This ball and wheel rim-turning machine is back geared, has a good belt width, and a range of speeds suitable for diameters from $\frac{1}{2}$ inch to 12 inches, and does rapid and excellent work. Such machines do not usually have an outboard support. In this machine an overhead bar, provided with the usual arm, can support the outer end of the work, as shown in Figs. 4 and 5, or can be slipped back out of the way, as shown in the wheel turning view, Fig. 6.

The driver *B*, Fig. 4, slides loosely on the squared shank of the live center *P*, so that the two screws *Q Q* can be tightened on the ball without cramping the work on the centers.

This ball handle and wheel rim-turning machine is also unpatented, and is very handy and quick in making changes, and does excellent work. It was designed by the superintendent, Mr. Frank Barnes, who is also vice-president of the company.

Figs. 7 and 8 show front and rear views of a worm gear hobbing machine, in which the worm gear and the hob are both driven at correct speeds. The hob is driven from the cone shaft with a reducing pinion engaging a spur gear on the hob shaft. The hob shaft carries outside of the spur driving gear one of a pair of miters, which drive the horizontal shaft *S*; the shaft *S* through the pair of miters in front drives the vertical shaft *T*, which has the long face pinion *P* on its lower end, and *P* drives the change gears, which give the proper rotation to the gear blank in process of hobbing. As the cut proceeds, the worm hob must be fed in toward the axis of the gear blank; to effect this feed the hob spindle is mounted on the slide *G*, which slide also carries the main driving shaft with its cone *H*. The feed cone is driven through two miter gears and a vertical shaft (none of which are visible), from the worm gear blank shaft, and by means of a belt carried under the idlers *D D*. The cone *C* drives the worm shaft *E*, which in turn drives the worm gear inside the cover *F* on the feed screw, which drives the slide *G*. This hob feed has a knock-off which can be set to stop the action of the machine at any desired point. This is comparatively a very cheap and simple hobbing machine, and is efficient in action. The designer of this machine objects to the crossing of the feed belt under the tighteners *D D*, and this will be avoided at the next building by changing the hand of the screw which feeds the hob-carrying slide *G* forward on the work.

Figs. 9 and 10 show a very original shaper attachment or fixture, by means of which various curved surfaces can be produced by the action of the planer tool. Various methods for producing wholly curved surfaces on a shaper or planer are well known, and are often used in the production of valve gear links and other pieces. These arrangements have generally depended on some construction of a pivoted work holder guided by a radius rod brought into action by the travel of the planer table. In the present case, however, the piece to be produced is a mortising chisel, which is tapering all ways slightly for the main part of its length, and then suddenly curves outward to join the round taper shank by which this chisel is secured to the slide which drives it when at work. Obviously, a radius rod alone could not move the work so as to produce this combination of straight and curved lines from the right line action of a shaper tool. The chisel blank-holding fixture is therefore hung on a trunnion, and the line of work is carried below the center of this trunnion, so that during the straight part of the cut the tendency of the thrust is to hold the screw *S* hard down on top of the shaper knee. The work is so placed that the curve in the finished surface begins a little beyond the vertical plane of the trunnion center. When the tool passes the plane of the trunnion center its thrust has a constantly decreasing down-holding effect on the fixture, and this makes it easy for the tappet *T*, carried by the shaper ram, to tilt the fixture by rocking it on its trunnion *R*, when the tappet *T* strikes the upward reaching trunnion arm *A*. It might seem at first sight that these chisels could be very rapidly and easily milled to shape, but a little reflection shows that there are many difficulties in the way of finishing by milling. No two faces of the chisel are parallel to each other, and the chisel body, oftentimes very slender, must be exactly in line with the axis of its taper shank, and also exactly in the middle of the shank. All of these indispensable qualifications are secured by this cheap and ingenious planer fixture, which is perfectly adapted to make all sizes, widths and thicknesses of chisels. The convergence of opposing sides of the chisel in cross-section, and the uniform side angle between the inclined faces and the third side (or front) of the chisel is secured by the location of the index holes in the fixture index plate 1, which forms a part of the shank-holding socket. The cord *C* passes from the arm *A* over the idler *P*, and has a not very heavy weight suspended at its lower end, the curve in the cut being made in such a plane with reference to the vertical plane of the trunnion, and the horizontal plane of the cutting tool point travel, as to nearly balance the fixture turning impulse and resistance. This trap is not patented, and shows the way to an added function of the planer or shaper which may be made useful for the production of some surfaces not easily finished otherwise.

Feed-Water Heating.

BY W. H. BOOTH.

A paper was recently presented before one of the engineering societies, dealing with the question of engine economies, and the author showed how very small had been the reduction in the water consumption of steam engines during the past fifty years. His remarks had special reference to the Cornish cycle in steam working.

In the old Cornish pumping engine the steam entered the top of the cylinder and pulled down the end of the beam, upon the other end of which was hung the pump rod. Then came the exhaust stroke, when the weight of the pump rods pulled the piston up and forced out the steam. But the steam did not escape to the condenser. There was a communication made between the top and the bottom of the cylinder, and as the piston rose the steam was simply transferred from one end of the cylinder to the other end. Then at the next down stroke the bottom end of the cylinder was opened to the condenser and the steam escaped. By this means the top of the cylinder which exhausted steam at a considerable temperature was never allowed to fall in temperature by reason of any communication with the condenser.

The final temperature of expansion became the lowest temperature, and the condenser only influenced the bottom end of the cylinder. This method of working has come to be known as the Cornish cycle, and much is claimed for it as being one reason why so very long ago and with such comparatively low pressures, such very good results were obtained by the Cornish engineers. The

heavy cost of coal had, it is claimed, very much to do with the attention paid to fuel economy in Cornwall. For my own part, I am much inclined to doubt this, and to attribute the economy to competition between engineers. Here was a certain industry—the pumping of water, and the duty was one that could be expressed in foot-pounds of work done; and to produce the largest number of foot-pounds of work per bushel of coal was the aim of the engineers, rather than any saving in cost of fuel, though no doubt this became a close second. That it is not the cost of fuel that makes for economy is, I think, conclusively shown by other experiences. Industries which cannot well be compared with other industries use coal wastefully, whereas in the manufacturing districts, where fifty closely neighboring mills are all turning out the same class of goods, there is strong rivalry, though fuel is, perhaps, one-fourth the price that it is in the isolated case above named.

The Cornishmen were the then existing steam engineers whose place to-day has been filled by the textile engineers of the northern counties. The author of the paper concluded by saying that an engine on the Cornish cycle, with a feed heater placed in communication with the equilibrium passage, would probably prove as economical as a modern triple-expansion engine. His idea seemed to be that as the exhaust would have a pressure of about 10 pounds absolute and a temperature of 194° Fahr., about one-tenth of the exhaust steam might be abstracted whereby only about 5 degrees of temperature would be lost, and about 980 heat units would be added to the feed water per pound of steam abstracted. Thus each cylinderful of exhaust steam would yield to the feed water as much heat as would raise this 98° F. Thus, being supplied at 52 degrees or more—the natural temperature of well and mine water—the feed would be heated to 150 degrees by the waste heat in one-tenth of the exhaust steam, or to a higher temperature if the feed be taken from the hot well. The arrangement shown to secure this was simply a tubular water heater, the exhaust steam being upon the outside of the tubes, but there was shown no means for preventing the choking up of the heater with air which would gradually accumulate. This, however, one can see could very easily be overcome by means of a small air pipe leading off to the air pump, and, while quite sufficient to draw out all the air, too small to cause any temperature reduction, while the water could be drawn off by the same means or by a trap. But the idea seems just a trifle complicated. We know that if supplied with steam at the atmospheric pressure, the exhaust injector will feed water against a pressure of 70 pounds gauge pressure.

Is it, then, too much to surmise that with steam at a pressure of two-thirds an atmosphere the injector would at least supply the boiler feed pump with hot water at a considerable pressure, if not at 190 degrees, which is the temperature given by an ordinary exhaust injector? Obviously, an injector cannot feed direct to a pump suction, because it might at times be forcing into solid water, and to overcome this difficulty there must be either a relief valve to set free the flow when the limit of pressure is reached, or the injector must feed to the base of a large air vessel, the elasticity of which will enable the injector always to keep going. The gas bag of the gas engine serves a parallel purpose in storing up during idle and exhaust strokes, a large supply that is instantly available by the engine. But for this the engine could not work, excepting with very large supply pipes, and even then would cause great flickering of lights. From an ordinary condensing engine, in which the exhaust falls at once to the condenser temperature, the possibilities of exhaust utilization are much restricted. Many engines, however, have an exhaust pipe temperature as high as 130 degrees, even where the hot well is only 100 degrees, because of the difficulty in lowering down to the water temperature, and it has often occurred to me that advantage might be taken of this to heat the feed water somewhat above the hot well temperature, and One remedy is to return a part of the finally hot feed to the feed pump warming the feed to the safe point before it enters the heater.

The economy of the Cornish cycle of working would point out the truth as regards the question of cylinder condensation. It is still the fashion in a certain set to scoff at this as having no foundation in fact, yet it is difficult to understand how such an attitude can be maintained, and seeing that the theory was accepted many years ago by Alsatian engineers, under the leadership of Hirn, can we not explain something of the economy in steam that has been secured by the Swiss engine makers to this very acknowledgment which carries with it as corollary such strong inducements to attend to such apparently minor details as internal surface roughness or polish, and the reduction of the internal area of cylinders to a minim? Mr. Longridge, of Manchester, whose work on this question I have before referred to, and whose opportunities of experimental investigation are unequalled, is a strong upholder of the necessity of surface reduction. Some of us would like to have the opportunity of trying the effect of surfaces of different materials than cast-iron. Lead has been proposed as one on account of its low specific heat, but this property is not the only one. There are, besides, the properties of conductivity, smoothness, and capacity for taking and for retaining a polished surface, and upon the balance of these combined properties will depend the suitability of any substance. Economy is now seen to be something more than a mere attendant upon good workmanship or correct mechanical design. It involves the whole table of physical properties of the metals, as well as the steam table, and an ability to run at a high speed. This last, however, modified by the fact that the Cornish engine and some of the most economical of modern engines have been far from rapid movers.

London, England.

Pressure Regulators and Reducing Valves.

The increasing use of high steam pressures is familiar to engineers. In 1880 the average pressure employed was about 65 pounds. Ten years later, 125 pounds was not uncommon, and to-day 250 pounds, or higher, is frequently employed.

The use of these high pressures has made necessary some suitable provision to maintain the lower pressures required in many kinds of service.

Our illustrations, Figs. 1, 2 and 3, show the construction of a new reducing valve, made by the Foster Engineering Company, of Newark, N. J., and which they designate as their "New Class W."

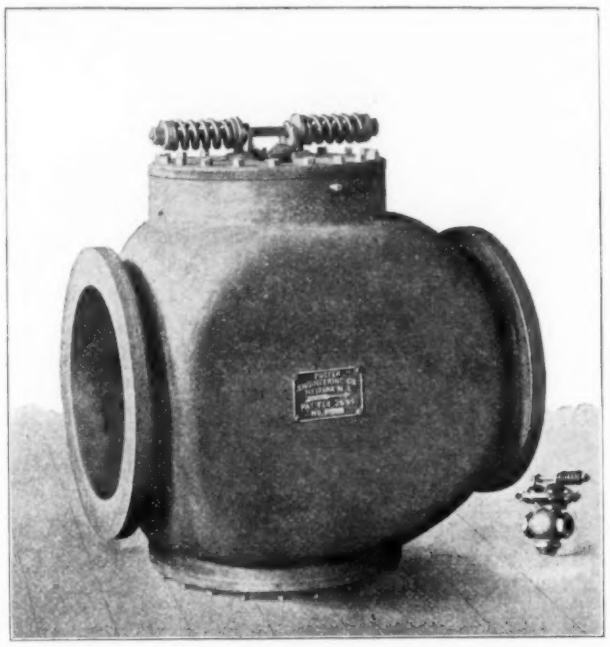


Fig. 1.

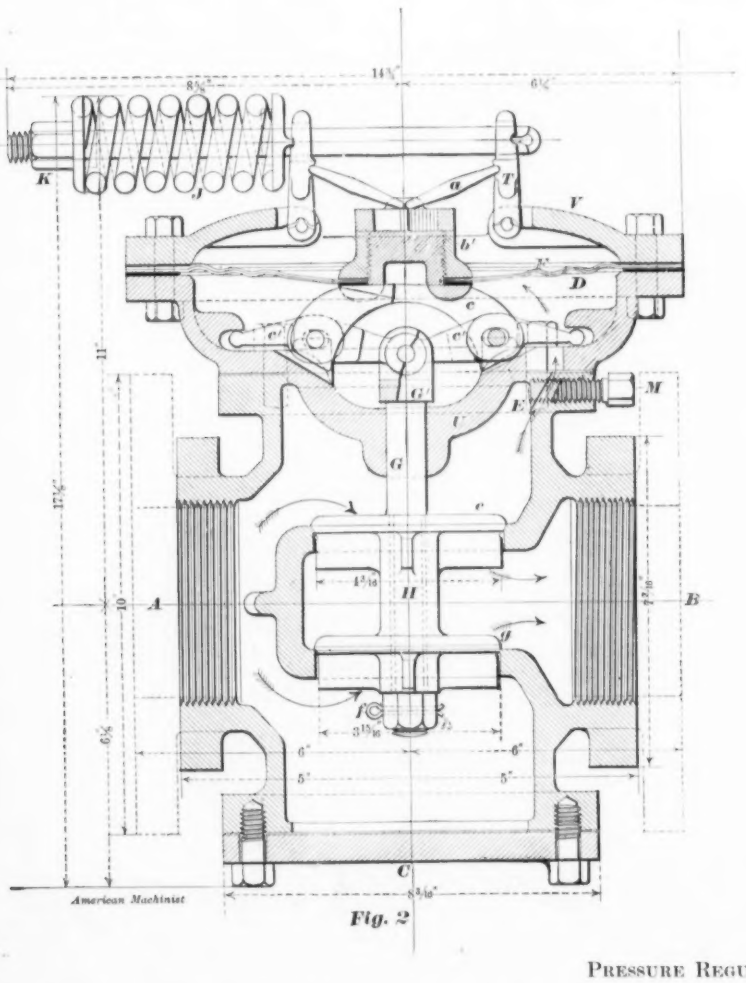


Fig. 2

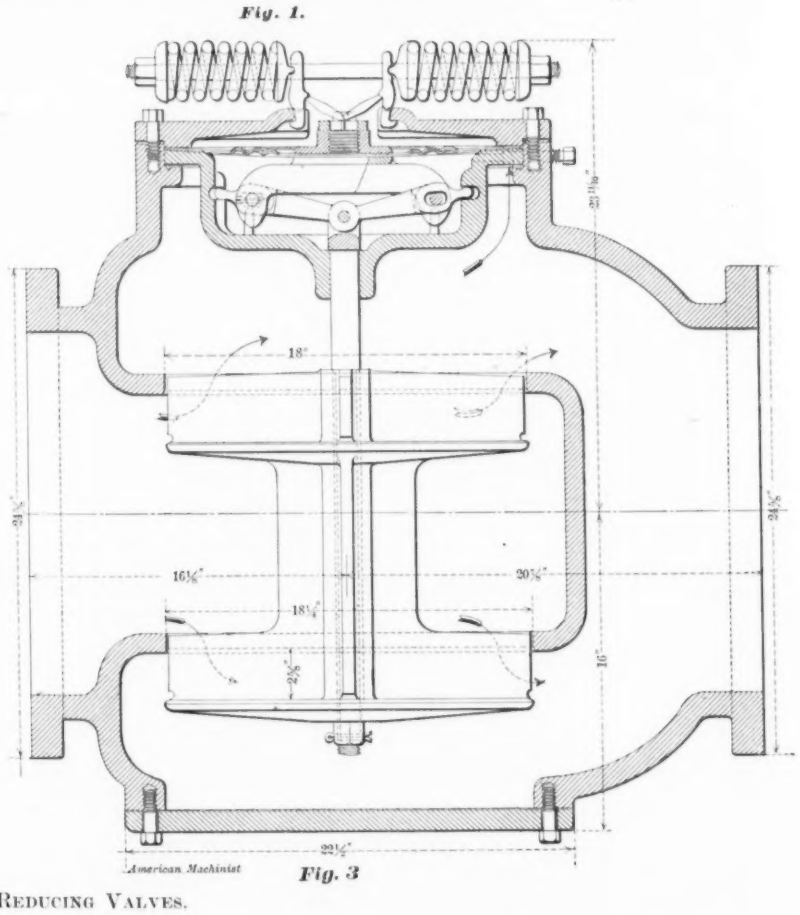


Fig. 3

Pressure Regulators and Reducing Valves.

The Foster Company manufacture valves controlled by a piston when ordered, but in view of their extended experience, have adopted the diaphragm valve as giving the best results.

Fig. 1 is a half-tone print, made from a photograph of an 18-inch Foster pressure regulator. The small valve by the side of the 18-inch is a one-inch, and gives an idea of the range in sizes.

Fig. 2 is a Foster pressure regulator converted into a relief valve. This construction has been made necessary to meet the requirements of steam users having both high and low-pressure boilers. Placed between the two systems it allows any excess of steam in the high-pressure system to enter the low pressure system.

Upon comparing Figs. 2 and 3 it will be noted that this valve may be operated by, and made to control, either the high or the low pressure. Fig. 3 represents the valve as performing the normal function of a pressure reducer, or controlling the lower pressure when that pressure is supplied from and maintained by a higher initial pressure. Assuming the same letters of reference to apply to the same parts of either Figs. 2 or 3, we refer now in our description to Fig. 3.

The inlet is at *A* and outlet at *B*, or *C*, as may be most convenient. Steam at the reduced or delivery pressure enters diaphragm chamber *D* through port *E*, and causes the diaphragm *F* to rise, and with it the stem or spindle *G*, which carries the double-seated valve *H*.

The power of the spring *J* is adjusted by the nut *K*, and acts in opposition to the pressure of the steam or other fluid bearing on the diaphragm, until there is an equilibrium established between these two forces. If the pressure on the delivery side of the valve increases, the increased pressure bearing on the diaphragm overcomes the resistance of the spring and draws the valve towards its seats until the equilibrium is restored. On the other hand, if the delivery pressure falls, the spring overcomes the pressure bearing on the diaphragm and forces the valve open until the equilibrium is again established.

The increasing power of the spring as it becomes compressed, is overcome by the increasing power of the toggles *a a*, as the angles are reduced.

Owing to the unequal expansion of metal under varying temperatures, it has heretofore been considered impossible to make both seats of a double valve steam-tight, unless such form was used as produced great friction and destroyed the sensitiveness of the regulator. This difficulty is overcome in the new Foster "Class W," by the following device:

The seat *e* is made at such an angle as will admit of a diametrical expansion without forcing the disk *g* from its seat to any appreciable extent; the angle of the lower seat is made more acute, so as to allow for the longitudinal expansion of the connecting shank between the disks, and yet, by diametrical expansion of the disk *g*, make a tight seat on the lower bearing.

A leak of the valve, unless so great as to exceed the demand for steam required, will not affect the operation of a regulator when there is a constant delivery, but if it is desired to shut off entirely the delivery of steam on the low-pressure side of the regulator, the valve must close off tight, or the delivery pressure will accumulate until the full initial pressure is reached, which would cause an engine when first started to "race" until the excessive pressure in the low-pressure pipe was worked off, and if steam was being supplied to radiators, the accumulation might be a source of danger.

To provide for the leaks caused by steam-cutting or foreign substances finding a lodgment on the seats, all Foster regulators intended to be applied to steam-heating, steering or hoisting engines, or other service where it is required to shut off steam entirely on the low-pressure side, are supplied with a small adjustable relief valve.

The relief valve (Fig. 2) operates to relieve high boiler pressures, which, in this construction, tend to open the valves, while the spring resists the opening. When the pressure bearing on the diaphragm, tending to open the valves, exceeds the power of the spring the valve opens, and as the pressure falls the valve will close.

The features of this valve are claimed to be a device compensating for the changing power of the spring, provision for insuring tight seats for a double-seated or balanced valve under varying temperatures, arrangements for shutting off steam from the working parts of the valve for repairs without disturbing the flow through the valve, full steam way through the valve without using abnormally large diaphragms, a relief valve to prevent excessive pressure and to give warning in case the valve leaks, freedom from friction and simplicity of construction.

Improved Drill Socket.

We illustrate herewith an improvement in the drill socket, made by the Cleveland Twist Drill Co., of Cleveland, Ohio, which improvement consists in milling into the shank of the drill a groove, the bottom of which is an arc of a circle, and the key is the same form. This not only drives the drill, but prevents its moving endwise either way within the socket. The engraving is made from a socket with drill inserted, and then a milling cutter sunk into it below the bottom of the groove and key.

IMPROVED DRILL SOCKET.

Chain-Pin Spinning Machine.

We give herewith an illustration of one of the very many interesting machines which have been developed to meet the requirements of bicycle manufacturers. This machine is for spinning heads upon the pivot pins or rivets which join the links of the chains, and by its use upsetting by blows is done away with, keeping the covered portions of the pin in much better shape, also doing away with the necessity for counter-sinking the blocks; which increases the life of the chain about 25 per cent.

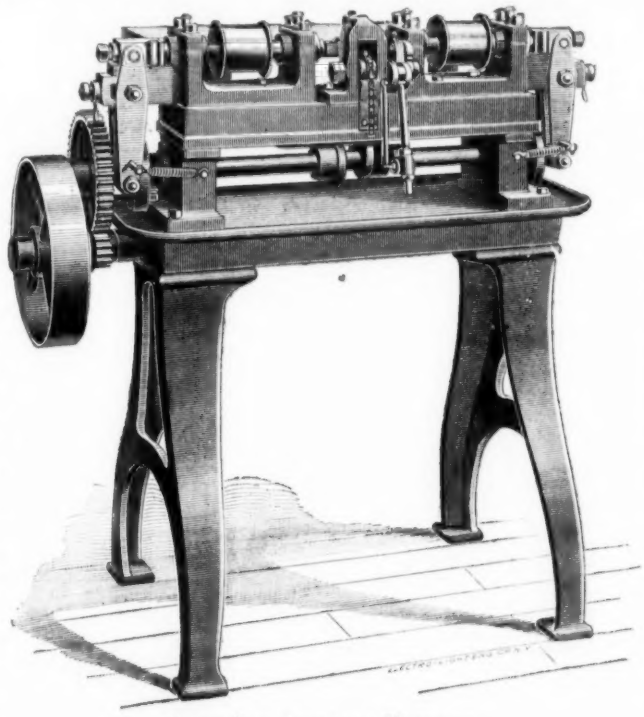
The assembled chain is placed by the operator on the table of the machine, and passed between the spindles, where the links are gripped by a suitable chuck.

The machine is automatic in its operation, and after once being started, the chain is drawn through by sprockets, stopping and chucking each link, successively, while the spinning proceeds.

The spindles carry in their forward ends hardened steel disks, which are made in halves, and have their peripheries turned to conform to the desired shape of the rivet head.

By means of cams and levers these spindles are forced against the rivet ends gradually and with considerable pressure, at the same time being revolved at a high speed by belts from the countershaft above; thus spinning up a well-formed, uniform head on both ends of the rivet at one operation, and doing the work at the rate of one to two feet of chain per minute, according to speed of machine, and ability of the operator.

The Garvin Machine Co., of Laight and Canal streets, New York City, is the manufacturer.



CHAIN-PIN SPINNING MACHINE.

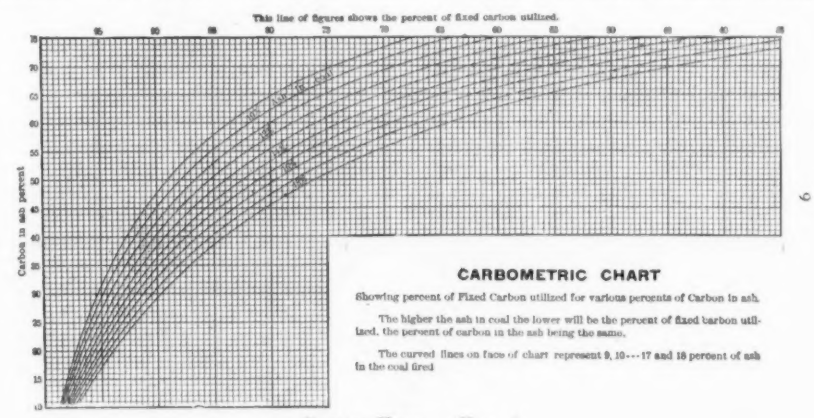
Cheap Fuel—I.*

SOME THOUGHTS UPON THE ECONOMICAL PRODUCTION OF STEAM, WITH SPECIAL REFERENCE TO THE USE OF CHEAP FUEL, BY A MINER OF COAL.

A coal miner or a coal merchant, it would seem, should be the last to advocate economy of fuel. But the coal miner, like the manufacturer, finds it to his ultimate interest to have his product prove as valuable as possible to his customers. Coal miners are large consumers of coal. In 1874 our collieries produced 1,315,355 tons of coal, and consumed 152,661 tons, or 11½ per cent. of it for steam for the work, the largest item being the pumping. Coal miners used to think that coal cost nothing, and in a steam plant only the cost of the plant was considered. Some mines burn 25 per cent. of their production, so that economy of fuel is important even in coal mining and is the very corner-stone of success in most manufacturing businesses. To make steam requires three things: Fuel, furnace, boiler. To make *cheap* steam requires fuel, furnace, boiler, brains.

Anthracite coal contains from 75 to 90 per cent. of fixed carbon, 2 to 14 of ash, 1 to 2 of water, and 4 to 8 of volatile matter. Bituminous coal contains practically the same, except that the proportion of volatile combustible is much greater. The average composition of bituminous coal is 1 to 4 per cent. moisture, 4 to 12 ash, 15 to 35 volatile combustible, and 55 to 75 fixed carbon. Anthracite does not cake, but remains as placed in the fire, each particle burning from the outside only. Bituminous coal agglomerates into a spongy mass, so that the fine coal does not run through the grate bars as anthracite does, often with great loss. Either coal will clinker if the temperature will fuse the ash, and then a considerable amount of coal may be included in the ash unless prevented. Coals differ in this, and their values may be much affected by the facility in clinkering.

In calculating the cost of a given quantity of steam, it is necessary to consider: First. Interest on cost, and depreciation of plant. Second. Repairs. Third. Cost of water. Fourth. Labor. Fifth. Getting rid of ashes, and Sixth. Cost of fuel in the boiler house. In the selection of the fuel several points are to be considered. First. The transportation of the fuel. Second. Getting the fuel into the boiler house. Third. Putting the coal into the furnace. Fourth. Taking out the ash and the clinkers, and Fifth. Carrying away the ash. The analysis of the fuel will determine the number of heat units in each kind, and from it the approximate amount that will be lost in the stack and in the ash pit, and the relative value in heat units of each ton of coal. The practical question is not how many heat units are in the pound of coal, but how many can be utilized. If one coal had 80 per cent. carbon, 15 ash and 5 water, and the other had 5 per cent. ash, and 15 water, the number of heat units in each would be the same, or 11,720 British thermal units per pound; but in one case the number available would be 10,600, and in the other 10,488, assuming the waste products to escape at 500° F., for in one case .15 pound of water would have to be evaporated and carried off in the stack, while in the other case it would be .05 pound. In taking out the ash and clinkers, and hauling away the ash this would be reversed. Water would be got rid of by evaporation, but the ash must be carted away. The question of the amount of ashes to be carted away might make quite a difference in the choice of the coal. In some cases ashes are of actual value for filling in, etc., but often in large cities the cost of taking them away may add seriously to the cost of running the plant. In one large establishment it was found cheaper in the end to pay a good deal more money for a coal low in ash for the double gain of an increased quantity of available combustible, and the greater saving in the disposal of the ash. While it is of the greatest importance to reduce the carbon in the ash to a proper minimum, it may be done by firing very slowly and gently, thus greatly reducing the efficiency of the boiler, which will not pay, or the carbon in the ash may be kept low by allowing an excess of air to enter the furnace, and the loss due to the increase of free oxygen, nitrogen, and steam in the stack may far overbalance the low percentage of ash. Analyses of ash show from 9 to 60 per cent. of carbon in it, and a greater range than this may be found. The relative loss through the carbon in the ash for different coals depends not only upon the percentage of carbon in the ash, but also upon the per cent. of ash in the fuel, and the more impure the coal the more important it is to pay attention to the carbon in the ash. The carbometric chart, Fig. 1, shows for each per cent. of carbon in ash from 10 to 75, the per cent. of fixed carbon utilized when the ash varies from 9 to 18 per cent. The curved lines of the diagram are for the different percentages of ash in the coal from 9 to 18. As an example, we find that if the carbon contained in the ash is 65 per cent., and the coal contains 18 per cent. of ash, we utilize 56 per cent. of the fixed carbon, while with only 9 per cent. of ash we utilize 80 per cent. of the carbon. When the percentage of carbon in the ash is low the difference is much less. In too many boiler tests the ashes are deducted from the fuel fired, and the difference is


This line of figures shows the percent of fixed carbon utilized.
Carbon in ash percent
CARBOMETRIC CHART
Showing percent of Fixed Carbon utilized for various percents of Carbon in ash.
The higher the ash in coal the lower will be the percent of fixed carbon utilized, the percent of carbon in the ash being the same.
The curved lines on face of chart represent 9, 10 ··· 17 and 18 percent of ash in the coal fired

CHEAP FUEL.—FIG. 1.

* A paper read by Eckley B. Coxe, of Drifton, Pa., before the New England Cotton Manufacturers' Association, at Providence, R. I., on April 24, 1895. Condensed by and for the AMERICAN MACHINIST.

called the "combustible." We really want to know the water evaporated for the combustible in the fuel, and it is of no advantage to get a high evaporation with a pound of "combustible" by throwing away a lot of good fuel in the ashes.

A given amount of coal contains, First. Carbon and hydrogen; these, uniting with the oxygen of the air, furnish the heat. Second. Ash, nitrogen, oxygen, and water, all useless or worse. Third. Probably a little sulphur. This gives some heat, but has a bad effect upon any iron work it may come in contact with. We must burn this coal with air containing the oxygen that is necessary for combustion, and nitrogen and water that do harm, in such a way as to get the greatest number of heat units in the gases passing through or under the boilers, and to evaporate the greatest possible amount of water. We must lose much of the heat in the process. The unavoidable losses are: First. The heat lost by converting into steam the water contained in the coal, in the air, and that formed by the hydrogen, and in heating this steam to the temperature of the escaping gases, and Secondly. The heat necessary to raise the carbonic acid gas, the nitrogen, and the sulphurous anhydride to the stack temperature. With perfect combustion there will be some excess of oxygen to be heated. Some heat is lost in the ashes, and the unconsumed carbon in them is a loss not entirely avoidable. Heat is lost by radiation from the furnace and boilers, this loss being reduced but not eliminated by careful construction, and coating with non-conducting material.

The more or less avoidable losses are: First. Incomplete combustion, so that too large a proportion of carbon may remain in the ash, some of the carbon may form carbonic oxide instead of carbonic acid, thus losing 69.62 per cent. of its heat units, and some hydrogen and marsh gas may pass out of the stack, and their heat units be lost.

Second. Loss from excess of air. Theoretically, 11.5 pounds of air are needed to burn 1 pound of carbon, but practically, more than that must be used, because every particle of oxygen cannot reach its portion of the fuel at the right time. Generally the excess of air furnished is much greater than it should be, entailing a heavy loss. The unused oxygen and the nitrogen with it must be heated to the stack temperature, and some moisture also be converted to steam and heated. As vapor carried into the fire causes loss, wetting the coal or using a steam blast must be wasteful.

Third. Too high a stack temperature.

Fourth. Taking out the ashes too hot.

Fifth. Loss by radiation. The outside of the plant, back of the point where the gases cease to give up their heat, should be as cool as possible, either by thickening the walls, or by covering everything exposed with non-conducting material.

(Here follow several elaborate and valuable tables which our space will not allow us to reproduce.)

These tables show, first, how the economy in using cheap fuel decreases as the cost of transportation increases, and the more costly the fuel the more attention should be given to the avoidable causes of loss. Using buckwheat coal at the mills or factory, with double the necessary air and with the stack at 800 degrees, instead of the proper quantity of air, and the stack at 400 degrees, the loss is $0.539 per ton, while with pea coal the loss is $0.753. At the mines by burning the buckwheat coal under the same conditions the loss would be only $0.1075, while with pea coal the loss would be $0.2825.

Thus far it has been assumed that the combustion is complete. This is seldom the case, particularly where a steam jet is used, in which case 6 to 14 per cent. of carbonic oxide, and from 2 to 6 per cent. of hydrogen are often found in the stack gases, the hydrogen being a total loss, and 69.62 per cent. of the heat units in the carbon which is burnt to carbonic oxide. The oxide is always formed unless the bed of coal in the furnace is thin; the air on reaching the lower surface of the bed of incandescent fuel converts the carbon into carbonic acid, part of which, in passing through the incandescent carbon, is converted into carbonic oxide, the latter to a greater or less extent, burn in the furnace, uniting with the free oxygen in the gases that have traversed the bed of fuel. Carbonic oxide will unite with the oxygen only when the temperature is high—1,150 degrees to 1,500 degrees—so that if the gases go through the furnace too fast, and reach the cooler parts of the boiler before all the carbonic oxide is burned, it will not be burned at all.

Hydrogen is not often found in quantity in the stack gases unless steam is used for blast, so the analysis of the gases is especially important when the steam jet is used. There is a proper velocity for the flow of the products of combustion under or through the boiler, below which there is a loss of efficiency or in the water evaporated per foot of heating surface, and above which the percentage of unconsumed carbonic oxide, and possibly of hydrogen, is so great as to diminish the evaporation per pound of fuel.

Analyses of the coal, of the gas, and of the ash, are comparatively inexpensive. They not only tell us what results we are getting, and at what cost, but in most cases they tell us *why* it costs what it does. A good engineer knows "how to do what is required, what it should cost, and why each item of the cost cannot be eliminated."

There are three ways in general use for obtaining furnace draught—the chimney, the fan and the steam jet. The chimney carries off the deleterious gases where they will not make trouble, it costs little to maintain, and the variations of temperature, etc., can be compensated for by the damper. It is a very uneconomical heat engine where the heat used can be saved. A sufficient draught for burning the smallest sizes of anthracite coal cannot be obtained by it. The steam jet costs little to put in or to keep it in repair. It takes a great deal of steam to run it; it introduces a large amount of steam or water, into the fire, which all has to be heated and carried up the chimney, and what condenses and falls into the ash pit has to be re-evaporated. A greater disadvantage with it is that, unless carefully managed, there is a large development of carbonic oxide, hydrogen and marsh gas which usually carry off a great deal of heat in the stack. The fan is more expensive, costs more to keep in order, but is more economical, so far as heat units are concerned, and with it at all times it is possible to get the exact blast necessary for the best results.

Coal should be kept as dry as possible, and not exposed to the air, if it can be conveniently avoided. If exposed to the air and wet it should be got into the boiler house and dried as much as possible before using. Handle carefully to avoid breakage. The boiler plant should be carefully protected from water, snow or ice. The boiler house should be as warm as possible without discomfort, not by heating but by good construction. Water, moisture or steam should not be allowed to get into the coal, *even under a patent*. The temperature of the stack gases should be kept low by having the boiler and feed-water heater abstract as much of the heat as possible. The heating surfaces must be kept clean, particularly if forced draught and small coal is used, as then more dust will be deposited, and from that cause the efficiency will decrease rapidly.

While it is evident that the lower the temperature of the stack gases the greater will be the amount of water evaporated per pound of fuel, we may not know the best method of reducing their temperature. The hot gases come first in contact with the boiler, and enter the stack after leaving the boiler. Their temperature must be higher than that of the water, and the higher the pressure of steam carried the higher also will be the temperature of the stack gases. If we reduce their temperature to a minimum some of the heating surface near the stack will evaporate little water. In modern plants the gases after leaving the boiler are used to heat the feed water, which being at a lower temperature is able to absorb heat from them when the hot water in the boiler could not. A still further economy is ideally possible by using some of the remaining heat of the gases to warm the air taken into the ash pit.

I would have the highest possible temperature of combustion in the furnace, protecting boiler and furnace from direct radiation as much as possible, and would allow the gases to escape from the boiler at the highest temperature consistent with an economical absorption of their remaining heat by the feed water. If I were feeding 100 pounds of water a minute, I would try to raise the temperature of the gases leaving the boiler until the thermal units in them were about what could be used in heating the feed water to the temperature at which it could be placed in the boiler without allowing the temperature of the gases leaving the heater or economizer to be much above where they could do useful work. The higher the temperature of the gases leaving the boiler the greater will be the evaporation for the given heating surface, and also the higher will be the temperature of the feed water, and consequently the greater the evaporation for the cost of boiler. The feed water should pass through the heater in the reverse direction to the gases, the hottest gases meeting the hottest water, and, as they cool, still being able to heat the cooler water. After leaving the feed-water heater the gases might pass around outside or through metal pipes, and the air for the furnaces through or around the pipes, and much of the heat of the gases might still be abstracted and returned to the boiler. The objection to the latter arrangement would be its cost, and that it would kill the chimney draught so that a fan would be necessary.

The temperature of combustion in the furnace should be as high and even as possible to secure the highest efficiency. Our grandmothers always put the kettle on the hottest part of the fire when they wanted to boil the most water. In managing the fire, we should have an excess of air, but it should be as small as possible consistent with thoroughly burning the carbonic oxide, hydrogen and marsh gas; for if you have 3 per cent. of free oxygen, and with it 80 per cent. of nitrogen, and your stack temperature is 500 degrees, the heat lost is 12.27 per cent., but if you have 1 per cent. of carbonic oxide in the stack gases at 500 degrees, the heat lost is 16.12 per cent. The ashes when taken out should be as cool as possible, and should contain a minimum of carbon.

We should be uniformly economical. It is natural to be economical, or even parsimonious in certain things, and to neglect others equally important. One man will be careful to keep the temperature of his stack low, and pay no attention to the composition of the escaping gases. Another will be careful of the composition of his ashes, and put water on his coal, or allow nature to do it for him.

The second part of the paper embraces a description of the author's furnace for burning the smaller sizes of anthracite coal.

LETTERS FROM PRACTICAL MEN.

English vs. American Lathes.

Editor American Machinist:

Perhaps a few English ideas on the "English vs. American" lathe question may not be out of place. I have had good opportunities of comparing the performances of both kinds in the works where I am employed, and I am an admirer of both, and would not be without either of them. I have an English 7″x14″ swing, working next to an American 7-inch, both of good average make, and each of them will do a job well and quickly, but I can put work in the English one which I would not care to put in the American one, such as jobs with projecting lugs, which would soon knock the American slide rest to pieces. Also the gap in the English one enables many jobs to be done in it which could not be done in the other one, such as wheels, levers, etc., work fixed on angle brackets, etc., which perhaps only want boring and turning on the bosses, but are too large to be done with the ordinary hight of centers. The American lathe is handier in the apron, hollow spindle, and for light and medium work the tool post is very convenient, but the shape of the loose head stock prevents the best use being made (in my opinion) of the slide rest. The index plate on the American lathe enables any man to put screw-cutting wheels on which come within the ordinary range of threads, but practically all turners in English shops are expected to be able to find wheels for any pitch which can be required, and therefore no index is put on most English lathes. The usual English slide rest has four studs on top, which allows greater variety in the shape of tools and cutters to be held stiffly, than the American swivel tool holder. Also, the top of carriage in most cases has slots in for holding down work stationary while boring. Also the usual pitch of guide screw is two per inch, which allows a greater range of threads to be cut with the ordinary wheels supplied, which run from 20 to 120 teeth by fives. At two per inch the nut can be dropped in gear at any point in the case of a greater number of pitches than the American 5 or 6 per inch, and the reversing motion for screw cutting is not much used (in many cases where two pairs of fast and loose pulleys are provided on countershaft, they are used to get a different speed of the lathe in the same direction). The American fast head stock is praised by all English engineers I have come across, also the 3-jaw steady rest, but opinions vary as to vee or flat lathe beds. The English used vee beds in the first instance, but gradually got to flat beds, and I notice that some well-known American makers now use the flat bed for heavy lathes. The fact is that the English are using any American method which they think handier than their own, and sticking like leeches to the points they think superior in their own practice. Some English makers make both English and American type tools to suit their customers. I have a lathe, built in Manchester, which has American type bed (rather heavier than usual, but still not clumsy), hollow spindle, English loose head stock, English slide rest (also six tool turret which will fit on carriage in place of ordinary slide rest, when a quantity of similar work is to be done), American type apron, steady rest and fast head stock, but English system of screw-cutting wheels to cut threads from, say, one thread in 6 inches to 100 threads per inch. There is also a set of differential gearing under the fast head stock which enables us to cut any gas thread at once without changing any wheels. This is so arranged, however, that it does not interfere with the ordinary method of change gearing, as the same gas threads could be cut in the ordinary manner, if any accident occurred to the differential arrangement. Some injury has been done to American tools by a few makers, who, while professedly "booming" American methods and tools, have managed to make a mongrel tool, which combines the *dis* advantages of both systems. Like the American system, the English system is the outcome of its special conditions, and notwithstanding criticisms, it produces, I think, as good and as safe a return (or better) on the capital involved in it as any other system. We English suffer somewhat in the estimation of outsiders, because the firms who are most specialized in their tools and methods have been chary in giving any information about them, though there is now a tendency in the opposite direction. I think we have an advantage in respect to experience, as we get both English and American tools to work with, whereas our tools and machinery from England have to pay such a heavy duty that it is a wonder how any of them get into America. Certain lines, however (especially cotton machinery), get in in good quantities, so the English lathes and methods which produce them must not be far behind the American, when the goods can get in in spite of the duty. Though upholding many

of our English ideas, I again express my esteem for many American articles (especially the AMERICAN MACHINIST, which is very well known here); and, if possible, I will later on send views of some English tools, and descriptions of the conditions under which they work. I might add that our workmen handle either the English or American type lathe with equal facility.

JAMES VOSE.

Bolton, near Manchester, England.

A Criticism of a Criticism.

Editor American Machinist:

Your criticism of my book, "Theoretical and Practical Ammonia Refrigeration," in your issue of 2d inst., is in my opinion somewhat unfair and misleading, and I trust you will be good enough to insert the following comments in your next issue.

In the first place, you say: "A work of this sort should open with a clear description of the cycle of operation of each type of machine, tracing the action of the substances employed throughout their course."

In answer to that statement, I will say that the cycle of operation of freezing by ammonia is explicitly described on pages 27 to 30, both inclusive; and as this description of the principle of refrigeration is exactly the same for every type of ammonia machine, notwithstanding differences of construction, there is no need for me to refer to different types of machines in order to accomplish my aim, which is to explain the principle of the working of ammonia freezing machines in general and not in special.

In regard to your statement that — 460 degrees is nearer the truth for absolute zero than — 458.4, it must be borne in mind that in dealing with figures of this sort scientists are constantly *correcting* them, and if one were to wait until the absolute truth was arrived at, tables involving an immense amount of time and labor would never be computed. When the tables were started, —458.5 were the generally accepted figures for absolute zero, and the results of the computations with the use of those figures are sufficiently near the truth for everyday practical purposes.

You will pardon me, I hope, if I say that it would be better had you stricken out your criticism to the effect that "statements, such as 'the necessity of a gas absorbing heat when expanding,' etc., should be stricken out." Of course, numberless people are aware that it is necessary that a gas absorb heat in order to effect its expansion; but this book, like most others of its kind, was intended for the use of those who want to know, or for those who should, but do not know, and therefore that adverse criticism is uncalled for. ILTYD I. REDWOOD.

Brooklyn, N. Y.

Fast Lathe Work.

Editor American Machinist:

I have been much interested in the article on "Fast Lathe Work," by Mr. Chick, in your issue of April 25th, and, being engaged in a business requiring the production of a large number of cone pulleys, I should be glad if Mr. Chick would kindly furnish the following further details respecting the cone pulley job:

1. Size of lathe used.
2. Cutting speed and rate of feed.
3. How many cuts?
4. Have the pulleys a curved or a double-taper crowning, and how is the crowning effected?
5. Is the time given exclusive of finishing; and, if so, how long does the subsequent finishing take, and how is it done?
6. What is the money value of 35 minutes of the class of labor referred to?

Perhaps Mr. Chick may consider I am troubling him too much, but I believe that further particulars of such a remarkable job will be of interest to many of your readers as well as to myself.

ENGLISH TOOL BUILDER.

Sending Catalogs to Schools.

Editor American Machinist:

I have often wondered if manufacturers realize the importance of sending catalogs to technical schools. It has been my experience that the modern trade catalog is a great help in teaching mechanical drawing and machine design. In our elementary mechanical drawing I find that many of the cuts in a catalog may be advantageously used for copies. The student is thus made familiar with some of the best drawing practice, besides becoming acquainted with the names of prominent manufacturers.

To the instructor in machine design catalogs will offer unlimited suggestions for the design of machines or parts of machines, and to the student who designs a machine it is interesting and instructive to compare his design with those machines that have stood the test of actual use. When they are requested, most manufacturers seem glad to send catalogs, but I, for one, would be glad to receive them without being compelled each time to ask for them. They are undoubtedly valuable adjuncts to the work in drawing, and, of course, in ordering new machinery or supplies it is convenient to find what is wanted without the delay of writing for catalogs.

C. R. RICHARDS.

University of Nebraska, Lincoln.

A New Crank Pin Without Loss of Time.

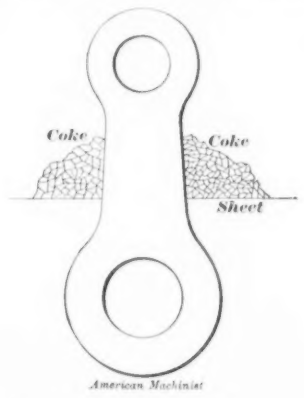
Editor American Machinist:

I have perused Mr. Chas. A. Hague's article on "Putting in a New Crank Pin."

I do just like he did—boring the crank for the pin, but instead of making it conical I am satisfied to bore it cylindrical. After this has been done the pin, entirely finished, cylindrical, is placed in the crank, the same having first been heated.

We take a difference of diameter between pin and eye of one millimeter per meter diameter [which is, of course, one-thousandth of any diameter.—ED.]

As you will see, this corresponds to our usual practice, save that in the works pins are pressed on, and in case of repair we have to open the eye by heating the crank in order to introduce the pin. There is nothing



so difficult as to make a conical eye or hole, while nothing is more easy than to make it cylindrical. That is the reason why in all our engines you could not discover one piece conically assembled; everything is cylindrical or spherical, shapes that are easy to make and to measure.

When we have to take a pin out of a crank (which has only occurred twice out of 300 engines supplied) we heat the crank, turning it upwards and placing an iron sheet around it. (See sketch.) We make a fire with coke and when red hot—a dark red—we take away the sheet and, turning the engine a half revolution, dip the crank head in a little cistern filled with water, and the pin comes out of the cooled crank of itself, and then we put a new pin in by heating the crank as above described.

Anent the erection of our engines, we simply pour cement under the frame or bed, same as "Superannuated," but we have our cement prepared very liquid in order that it may run and fill all the spaces. Therefore we place on the foundations, at 4 or 5 centimeters distance, say 2 inches, a little embankment of clay so as to form a reservoir or tank for the liquid cement to fill well all the places. A. BOLLINCKX.

Brussels, Belgium.

[We print the above with great pleasure, at the same time confessing to some curiosity as to how the method described of removing crank pins that have been shrunk in may strike our readers. The remark about spherical shapes may also have something in it for us.—ED.]

Utility of Hot Blast for Cupolas—A Correction.

Editor American Machinist:

The writer would be pleased to learn through the columns of the AMERICAN MACHINIST of any advantage or objections that have been found by any that have an opportunity to use hot blast for cupolas in remelting iron, and also, would be pleased to have sketches presented to illustrate the plans used for heating the air or carrying hot blast to cupolas.

In my article, published in issue of April 25th, on page 330, I find one error which I would be pleased to have you publish a correction of. This is found in the last two lines of the second column, and which now reads, "Hard and white iron, which means low silicon and low sulphur, is generally." It should read, "Hard and white iron, which means low silicon and *high* sulphur, is generally." The error is, as you will perceive, in saying "low sulphur," when it should have read *high sulphur*.

THOS. D. WEST.

An Explosion Preventer.

Editor American Machinist:

For the past few months there has been considerable talk in the newspapers of our State regarding a so-called discovery by an ex-railroad engineer. It is said that this man has invented an indicator, by the use of which boiler explosions may be entirely prevented.

In brief, the indicator is a sort of pyrometer extending inside the boiler, and connecting with the steam gauge, where an extra hand acts as a register of the temperature due to the varying pressures, and indicating the approach of an explosion. The inventor claims that many boiler explosions are due to what he calls superheated water; that where superheated water occurs there will be, without any warning whatever (except by his indicator), a very sudden and enormous rise in pressure sufficient to rupture the boiler. Just before this point is reached his indicator sounds an alarm, which gives the attendant time to prevent an explosion.

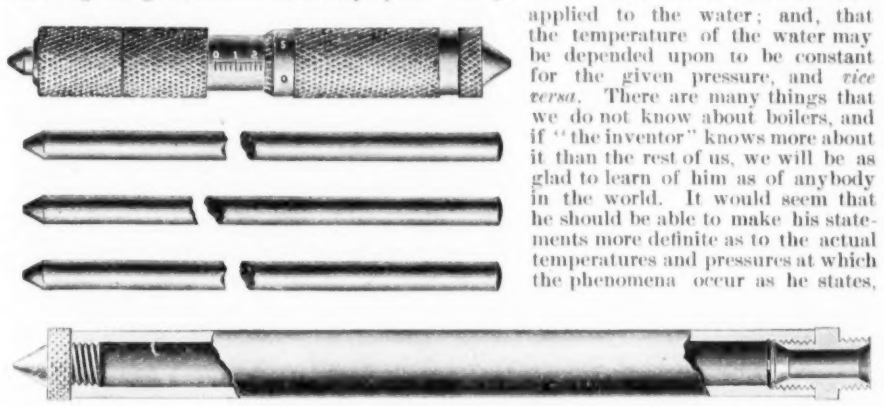
In an article written by the inventor in a local paper, he offers, in proof of the excellence of his indicator, to attach it to any boiler, and show the danger point by the indicator alarm, after which, if the pressure were maintained, an explosion would follow, although there is to be no apparent rise in the gauge pressure, and at no time is there to be less than three inches of water over the crown sheet, and the gauge pressure shall not be at any time more than a hundred pounds. This condition is to be maintained until the superheated condition of the water causes the instantaneous rise in pressure which causes the explosion. He further offers to again raise the temperature and cause the alarm to sound, but this time, the preventives not being applied, to explode the boiler, all the conditions to be exactly as before. He does not state whether he is to stand by and regulate the explosion or not. Probably not.

Immediately after this publication, appeared a number of articles by various steam engineers stating the impossibility of such a thing, and showing the absurdity of the whole affair. In the face of it all, he states that he will do what he agrees to do, and is willing to wager a considerable amount that he will succeed. His offer has been accepted by one of the engineers at Fargo, who is anxious to have his boiler exploded under the conditions named, and is now awaiting the appearance of the inventor and his machine.

"In his own country," the inventor has the reputation as being a genius, and is conceded to be a man of sound brain, who is an experimenter and a worker in engineering problems of no mean ability. His friends claim that his experiments are sufficient to carry out his statement, and are confident that he has made a discovery which will account for many of those mysterious boiler explosions. Will the editor please comment? E. SPENCER.

Fargo, N. D.

[We will watch anxiously for the result of the proposed experiments at Fargo. In the meantime, for the lack of sufficient evidence to the contrary, we must hold on to our belief in some of the apparently established facts regarding boiler explosions, such as that the boiler explodes because it is not strong enough to stand the pressure; that the pressure is traceable back to the heat applied to the water; and, that the temperature of the water may be depended upon to be constant for the given pressure, and *vice versa*. There are many things that we do not know about boilers, and if "the inventor" knows more about it than the rest of us, we will be as glad to learn of him as of anybody in the world. It would seem that he should be able to make his statements more definite as to the actual temperatures and pressures at which the phenomena occur as he states, and the amount of superheating that it is possible to give to water in free communication with a sufficient steam space. We do hope that nobody will be hurt.—ED.]



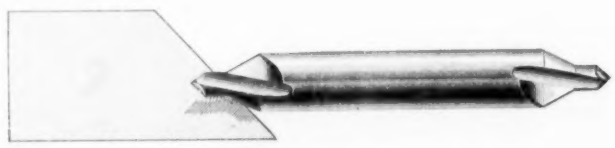
INSIDE MICROMETER.

Inside Micrometer—Starting Holes.

We present herewith engravings of some of the latest developments in the tools manufactured by J. T. Slocomb & Co., of Providence, R. I.

The first of these represents the plainest and simplest form of the inside micrometer caliper, *i. e.*, without depth gauge or graduated bars; the bars shown being plain, and differing from each other in length by one inch.

Below this we show an extension for this caliper. This extension consists of a piece of brass tube with steel screw tips, as shown, and is adapted to screw to the end of micrometer thimble in the place of the regular short tip screw.



STARTING DRILL.

The extension greatly increases the range of tool, making it adapted for the largest measurements, and is, of course, inexpensive.

The third engraving illustrates a use for their center drills and countersinks, which has been a development in their own shop practice, and may be usefully suggestive to others. It is found that such drills used on inclined surfaces work very well in starting the drilling just where it is wanted, the operation being obvious. It is also found that they work well in starting holes on flat surfaces which have been laid off by measurement and center punch, a small drill being used ground to the same angle as the punch. Mr. Slocomb writes us that he finds it easy to get holes to position within .003 inch by this means, and that the method is much preferable in every way to the usual one of drawing by chisel.

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NEW YORK, MAY 23, 1895.

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English vs. American Lathes.

It is an excellent thing to form the habit of hearing both sides before deciding questions that are of such a nature as to make it possible for them to have two sides. It is also well to remember that nearly all questions, excepting those of morals, have two sides.

The question of the relative merits of American and English, or other lathes, is not a moral question nor a question of patriotism. It is purely a mechanical, or, as some would perhaps prefer to put it, an engineering question, and we should be sure not to forget that the man who differs from us on such a question and honestly tells us so, and gives the reason, may be doing us a much greater service than he who pats us on the back and tells us we are undoubtedly the smartest people in the world, that nobody else knows much of anything, anyway, and that our lathes are really the only lathes worth using.

As we have stated in a former issue, we think we have good reason for believing that so far as the English and the American lathe can be compared at all, the latter is superior; and we are, of course, glad that we are able to honestly think so, but at the same time we are very much interested in the views of others on the subject, and are especially interested in the views of our English correspondents who have had—what few American mechanics have—experience with both machines. Two weeks ago we published a very interesting letter from an English machine shop superintendent, in which he gave his opinion, based upon the use of about an equal number of lathes of both kinds in the same shop, and he gave his opinion of details of each machine—some of the features of ours being superior and some inferior. This week we publish a communication from Mr. Vose, an Englishman of experience, who frankly avows himself an admirer of both machines and says he would not dispense with either of them in his shop. His letter contains many interesting points.

We happen to know that Professor Sweet's opinion is much the same; he does not, as some have assumed, think that the American lathe is, considered as a whole, inferior to the English lathe, but does think that certain features of the English lathe, considered by themselves, are superior to similar features in our practice—at least for many purposes, and, in our opinion, whether he is right in this or not, he has done no more creditable thing than by his honest expression of opinion, calling out these letters from English users of both American and English lathes.

We know that he has been severely criticised in some quarters for the expression of his views, and that we have been criticised for publishing them; but we feel confident that the net result of the discussion will be good, and that few if any men in America have a better right to hold and to express opinions regarding machine design than has Professor Sweet, who has done so much work that is valuable and educational in machine design.

It is perhaps proper for us to add that we expect soon to publish engravings and description of an English lathe, which will enable our readers to make comparisons.

Different Ways of Doing Things.

Last week we published an article giving a graphic method of finding square roots, squares and reciprocals. It may be of interest especially to our younger and, it is to be supposed, more studious readers as suggesting a different way of doing some things, although we cannot think that the method described can have more than a limited range of applicability. The writer says that the square root of "any small number, whole or fractional, may be found with sufficient accuracy, etc." The range of small numbers, to our thinking, should be, say, from one to two, and we should not be too exacting as to the accuracy attained. The determining of the length of a line "to two or three places of decimals," when one end of the line is at its intersection with another line at a very acute angle, requires either phenomenal skill, or faith or credulity, or a happy combination of them all.

We do, however, believe in knowing more than one way of doing a thing, because there is no such thing as an absolutely right way of doing anything, but only a best way as far as we know at the time, and in choosing among different ways it will often save us time if we know first of all what to reject. A familiarity with and a facility in the use of graphic methods is very desirable, and we would be the last to deprecate their employment, as it often happens that they are both quicker and more accurate than any other. Only the other day in running over a column of variable values in a table it occurred to us that there were errors at one or two points. We picked up a sheet of section paper and selecting a base line laid off the successive perpendiculars to scale and corresponding to the values given in the table. A glance at the curve thus delineated showed the two points where the table was in error and enabled us to put it right.

There is no greater difference among men, perhaps, than in the range of their methods, and, of course, the progressive and presumably successful man, is the one who knows two or three ways of doing a thing, and can take advantage of either to suit the different circumstances, rather than the man who knows only one way, even if that is the right way.

At one time a certain young machinist was standing at a lathe two hours a day with Alick as a near neighbor on one side, and Bill just as near on the other. Whenever a new job came along to the young machinist, Alick was always quick to volunteer all the particulars about the right way to do it, and the way that he always did it. But it happened that Bill was more often consulted and it was noticed that he was never so ready to lay down the details with such precision. Bill often could not remember the way that he did a certain job the last time, and he probably would not do it in the same way next time. Alick and Bill were both of them very good lathemen, and the last time they were heard from, Alick was still at the lathe, while Bill had an extensive shop of his own.

A Job that Should Be Pushed.

An important addition to the defenses of New York Harbor will be the erection of an up-to-date fortification upon Romer Shoal, which lies between Sandy Hook and Coney Island. The proposed work will consist of a series of heavily and completely armored turrets (probably four) mounting two guns each. The armor, of course, may be as heavy as may be necessary to render the turrets invulnerable, and the guns may be heavy enough to throw projectiles capable of piercing any armor afloat. The designers could not escape some embarrassment in determining the details. "The thickness of the armor plate will be determined by the relative status of armor and gun at the time when the forts are ready for their steel protection, and—to a certain extent—the caliber and length of gun will also be dependent upon that relative status," which means that the work should be rushed to completion as rapidly as possible to avoid the necessity of immediate reconstruction.

It seems that a new way has been found by which a corporation can escape liability. An explosion occurred at the works of the New York Oxygen Company, by which several employes were injured very severely. Suits were brought for damages, but before they were concluded the officers of the company asked that it be dissolved, which it seems the court was obliged to allow in face of the fact that it was claimed that this petition for dissolution was made not by reason of any necessity growing out of the condition of the company's affairs, but solely to escape liability in the suits. The judge in permitting dissolution said the situation was the result of a defect in the law of the State, which ought to be remedied, and scarcely any fair-minded person will be found to disagree with him, we think, as to the crying need of reform in this matter. Individuals cannot escape responsibility in any such way, and it is monstrous that corporations should be allowed to do so.

Eckley B. Coxe.

By a sad coincidence we publish this week the first half of Mr. Coxe's paper upon "Cheap Fuel," and the announcement of the untimely death of its author.

Daniel Coxe came to America in 1702. He eloped with a Quaker heiress, Sarah Eckley, in 1707, and they were married in the woods, by firelight, by the chaplain of Lord Cornbury, Governor of New York and Jersey. Tench Coxe, grandson of the above, statesman, financier and author, was Commissioner of Revenue under George Washington. His son, Charles S. Coxe, the father of Eckley B. Coxe, was Judge of the District Court of Philadelphia. Such a genealogy is rare indeed in this country, and a genealogy that can be traced with honor and pride as far as it extends both upward and downward is almost unique for any land.

Eckley Brinton Coxe was born in Philadelphia, June 4, 1839, and died at his home, Drifton, Pa., of pneumonia, on May 13, 1895. Mr. Coxe was graduated from the University of Pennsylvania in 1858. He studied for two years in the Paris School of Mines, a year in the Mining School of Freiburg, and spent two years in visiting the mines of Great Britain and of Continental Europe. After his return to this country Mr. Coxe with his brothers began mining anthracite coal upon lands inherited from his grandfather. This property is now said to be worth $10,000,000, and Mr. Coxe was the largest individual coal mine operator in the country. He was, of course, a large employer of labor, and may be said to have been almost an ideal one. For their employes the firm erected houses supplied with every sanitary comfort and convenience, with an ample supply of garden ground to each. Gas, water from artesian wells, a large public hall, a reading room and library, two or three places of worship, a cemetery, buildings for public schools, and, finally, a mining school for the scientific education of boys desiring it, were among the free gifts of Mr. Coxe and his brothers. When the long strike of 1871 was ordered by the Miners' Association the generosity of Mr. Coxe and his wife supported not only their own men and their families, but saved from starvation multitudes of other miners in the Hazleton region. After that time the Drifton miners were not to be found taking part in strikes from whatever source inaugurated.

In 1872 Mr. Coxe published a translation of Weisbach's "Mechanics of Engineering and Construction of Machines." He was well known throughout the United States for his practical and scientific knowledge of mining. He was a prominent member of the American Institute of Mining Engineers and of the American Society of Coal Engineers. He was a charter member of the American Society of Mechanical Engineers, did much toward the promotion of its growth and prosperity, contributed to its transactions, was ready in all discussions, and the society honored itself by conferring upon him the honor never before accorded of a re-election to its presidency. Mr. Coxe was president of the society during the Columbian Exposition and the World's Engineering Congress, and was able to meet the most eminent engineers and scientists of the world upon fully equal terms, and as the urbane and accomplished gentleman conferred dignity upon his office and honor upon the society. He was fully equipped at every point. At the Montreal meeting, after a speech in English, he at once, upon the suggestion, made another speech in French, and we are assured that he could have done the same thing as easily in German. We remember how, when presiding at the New York meeting, his eyes filled with tears and his voice choked with emotion as

he spoke of an aged member who had been unable to maintain his financial standing in the society, and advocated special provision for such honored but unfortunate members.

Of late years Mr. Coxe has been especially interested in the utilization of fine coal and coal dust that has heretofore been recklessly wasted. The paper which we condense and reproduce is only a sample of his contributions upon the subject. If it should appear that, after all, the saving which his automatic stoker accomplishes is principally in saving the waste fuel at the mines, when we remember that the mines themselves consume as high as 25 per cent. of their total output for their own power, the gift to the world in the economy effected is an enormous one.

To us the most remarkable thing about Mr. Coxe was that notwithstanding his multifarious interests, and the range of his business engagements, his knowledge of and attention to detail was phenomenally minute and exhaustive. This in his papers and addresses was often carried to a length that might make them appear tedious to some persons, but to him it was merely that he could not be satisfied except by thorough and conscientious work. Mr. Coxe's death in the fullness of his powers can only be regarded by all who knew him with unmixed regret.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(211) A. B., Jeffersonville, Ohio, asks: Can Sandow or any of the modern Hercules develop one horse-power at any instance by lifting or otherwise? *A.*—We believe so.

(212) H. P. T., ——, asks: By what means is the exact amount of error in the diameter of a cylinder ascertained to the thousandth part of an inch, as described in your issue of 2d inst.? *A.*—It is usually done by some form of an inside micrometer caliper, such as have been at various times described in our columns, and are, by at least one firm, manufactured for the market.

(213) J. C. T., ——, writes: Can a propeller which is a taper fit on a shaft, held in place by two keys set at 90 degrees from each other, be drawn off, the keys remaining fixed in the shaft? *A.*—We understand in this case that, as usual, the sides of the two keys are planes parallel to the axis of the shaft, then the sides of the keys will not interfere with the removal of the wheel. The draft of the key will not interfere with the removal unless its taper is greater than one-half of the taper of the shaft, or unless the distance of the outer end of the key from the center of the shaft is greater than the distance of the inner end from the center.

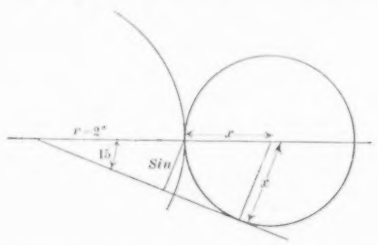
(214) R. B. L., Bridgeton, N. J., writes: I have a series of gears working together. One has 133 teeth; one, 255 teeth; and one, 327 teeth. I start the first gear (133 teeth) at 20 revolutions per minute, say, at 6 o'clock in the morning. Please tell me of a method which will enable me to compute the time at which the wheels will be in the same position as when they started. *A.*—Find the least common multiple of 133, 255 and 327; this multiple is 3,696,735. Divide this number by 133, which gives us 27795 for the number of revolutions which the wheel with 133 teeth will have to make to bring all the gears back into the original positions. This wheel makes 20 revolutions per minute, hence it will have to run $\frac{27,795}{20} = 1,389.75$ minutes, or 23 hours 9¾ minutes to bring the whole series of wheels into the original position. The reason for dividing the least common multiple by the number of teeth in the small wheel is that its speed is given.

(215) W. S. K., Detroit, Mich., writes: A tubular boiler 36 inches diameter and 12 feet long generates steam at 10 pounds pressure from feed water at 212° Fahr., and is rated at a certain horse power. What will be the horse-power of the same boiler if steam is generated under a pressure of 100 pounds? I understand that it will require a greater quantity of fuel at 100 pounds pressure than at 10 pounds pressure. What I want to know is the relative horse-power of the same boiler working under different pressures. *A.*—If more coal is used under one condition of working than under another, there will be a difference in the quantity of water evaporated, consequently before the horse-power of the boiler can be determined, the quantity of water evaporated in a given time must be known. If the boiler is running at its full capacity, and generates steam under a pressure of 10 pounds, and if at another time it generates steam under a pressure of 100 pounds, and is then also running at its full capacity, or, in other words, if the boiler evaporates the same quantity of water in the same time from the same feed-water temperature under all conditions, then the boiler will develop the same horse-power at all times. It does not necessarily follow that when steam is generated under a pressure of 100 pounds more fuel will be required than when steam is generated under a pressure of 10 pounds.

(216) F. L. A., Matawan, N. J., writes: We have shut down two 90 horse-power boilers and would like to know of a good way to keep them from rusting. Shall I fill them with water? Please inform me of a good method to accomplish this. *A.*—When a boiler is to be taken out of service do not blow out the water by the pressure of the steam; the water must be allowed to remain in the boiler until it is cool, and then permitted to run out through the hand hole and blow-off cock; after this clean the boiler thoroughly. There are several ways of preventing the boiler from rusting. One way is to refill the boiler gradually, after it has been cleaned, with warm water, care being taken that the boiler is also warm before refilling so as to avoid the danger of unequal expansion; if cold water is used a light fire should be kindled in the furnace after refilling, so as to heat the water; when nearly full one or two gallons of crude oil should be put in the boiler, after which the water is permitted to run out slowly through the bottom blow-off cock. The oil which floats on the top of the water will adhere to the inner surface of the boiler as the water level is lowered. When the boiler is empty close it up tight. Another way is to clean and dry the boiler thoroughly, and to protect it from moistures, a light fire of shavings should be kindled in the ash pit about once a week. Some engineers fill the boiler quite full of water and close up tight.

(217) C. B. S., Hagerstown, Md., writes: What is meant by sub-press work, what is the difference between a sub-press and the ordinary power press? *A.*—A sub-press is simply a small frame with a base plate and upright, the base plate adapted to hold a die, and the upright fitted with a plunger adapted to carry the punch. In this frame the die and punch are permanently adjusted in their proper relation to each other, and the plunger is then given its motion by the slide of the regular punch press, the sub-press being placed upon the bolster of the punch press. When jobs are changed upon the machine the entire sub-press is removed without disturbing the adjustment of the die and punch, and the arrangement enables much finer and closer punching work to be done than is usually possible by the ordinary methods. In fact, practically all the finer class of punching is done by the use of a sub-press. You will find an article on sub-press work by the late Ambrose Webster, in our issue of March 5, 1891. 2. Where can I find matter pertaining to making and hardening punches and dies, also drop forging dies? *A.*—You can find a good deal of information on these subjects in the back numbers of the AMERICAN MACHINIST. You will also find general directions for hardening and tempering in Appleton's "Encyclopedia of Applied Mechanics"; also in some of the publications of the Crescent Steel Co., Pittsburgh, Pa., which we think will be sent upon application.

(218) L. L. G., Streator, Ill., writes: I notice in your answer to Question 162, in your issue of April 18th, you state: "The sine of an angle of 15 degrees is .2588, consequently the line EG is (.2588 × radius of 2 inches) = .5176 inch long." This, no doubt, is a mistake, as it should have been



the tangent of the angle of 15 degrees, which is .267949 × 2 inches = .535898 inch; this multiplied by the tangent of 52½ degrees or 1.3032254 = .698395, and by 2 = 1.39679 for the diameter of the ball. I was interested in this example, as the day before I had occasion to work out the same question and had solved it in another way, which, although no easier, got rid of looking up one angle; in connection with the computation, see accompanying sketch. Let r = radius of the journal = 2 inches; then:

$$(r + x) \sin. 15° = x,$$
$$r \sin. + x \sin. = x,$$
$$r \sin. = x - x \sin. = (1 - \sin.)\, x,$$
$$x = \frac{r \sin.}{1 - \sin.},$$
$$\text{diameter} = \frac{2 r \sin.}{1 - \sin.},$$
$$\frac{2 \times 2 \times .258819}{1 - .258819} = 1.39679 \text{ inches}$$

for the diameter of the ball. *A.*—We thank our correspondent, and also F. C., Montreal, Canada, for calling our attention to the error. We should have used the tangent instead of the sine of an angle of 15 degrees, which will give for the diameter of the ball 1.396 + instead of 1.349 inches.

(219) C. A. W., St. Louis, Mo., writes: I have a strip of a soft steel plate bent over double to a distance of 5 inches between the ends; the strip is 1 inch wide and ¼ inch thick. I want to reduce the distance between the inner surfaces of the strip to three times the thickness of the strip. This closing down is to be done by a continuous pressure and not by a hammer blow. I wish to calculate the force required for closing strips of this kind of various widths and thicknesses; please give a formula for computing the required force. *A.*—In cases of this kind the metal is strained beyond the limit of elasticity, and therefore no formula can be given which will give satisfactory results in all cases without experimenting on strips of the particular kind of steel used. The following formula gives approximate results:

$$W = \frac{S}{\frac{1}{A} + \frac{l}{\frac{1}{6} b\, h^2}};$$

in which W = the pressure in pounds, S = ultimate stress in pounds per square inch, b = width of strip in inches, h = thickness of strip, l = one-half the distance in inches between the inner surfaces of the metal. For the ultimate stress S we may take 100,000 pounds, and if the strip is 1 inch wide and ¼ inch thick and closed to a distance of ⅜-inch between the inner surface, then will $l = \frac{3}{8}$, $b = 1$ inch, $h = \frac{1}{4}$ inch, and $A = \frac{1}{4}$ square inch; substituting these values for the letters in the given formula, we have

$$W = \frac{100,000}{\frac{1}{.25} + \frac{.375}{\frac{1}{6} \times 1 \times .25^2}} = 2,500 \text{ pounds}$$

for the required pressure. The correctness of this result depends much on the value of S, and for correct results this value should be determined by experiment. The above formula is used for all breadths and thicknesses of strips. 2. Will the pressure be directly proportional to the width of the strip? *A.*—Yes. 3. Have the effects of temperature on iron been investigated? *A.*—To some extent. See "Mechanics of Materials," by Prof. M. Merriman.

(220) Reader, Johnstown, N. Y., writes: Please inform me what causes an engine to run unsteady; it seems to be at regular intervals; it will run very fast and then slack up a little. The engine can develop 14 horse-power, steam-pipe inlet is 1¼ inches diameter, exhaust 2 inches diameter. The load at present is very light, not requiring more than 4 horse-power, but the load will be greater when all the tools are put in operation. Is the unsteadiness of running due to the light load, or is it due to the governor? *A.*—The cause may be due to some imperfect action of the governor; but since you do not state the kind of governor and connections used, we cannot positively say whether the cause is due to the action of the governor or not. With a light load the pressure of the exhaust steam may at times not be sufficient to keep the exhaust pipe clear of the water due to condensation, which will reduce the speed of the engine until the pressure of the exhaust is sufficient to clear the exhaust pipe, and when this is cleared the speed of the engine will increase, hence the cause of the unsteady running may be due to the presence of water in the exhaust pipe. 2. Is it proper to belt an engine from the fly-wheel or not? *A.*—If the diameter of the fly wheel will give the desired speed to the machinery which the engine is to drive, it is proper to belt the engine from the fly wheel, in fact, in many engines the driving pulley takes the place of the fly wheel, or, in other words, the fly-wheel rim is made wide enough for the width of the belt so that the engine can be belted from the fly wheel. 3. Can you name a solution or bath into which to dip metals that have been brazed, which will remove the scale formed by the borax used in brazing, but will not injure either the steel or brass? *A.*—We do not know of such a solution and are inclined to think that a mechanical process such, for instance, as the use of wire brushes, will give the best results. 4. Do you know of a solution to dip steel into to give it the proper temper without drawing? *A.*—There are those who claim that this can be done by using water if the hardening heat is properly graded, but we do not think the degree of skill required for this method is generally available. Some method of drawing after hardening is usually required.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 412.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Air compressors for all purposes and pressures. Clayton Air Compressor Wks, 28 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Foster Engineering Co., Newark, N. J., Pressure Regulators, Reducing Valves, Pump Governors.

Yacht engines and boilers. Great variety. New catalog free. Willard & Co., 197 Canal St., Chicago.

Air Hoists and Cranes, send for new circular. Whiting Foundry Equipment Co., Chicago.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

Efficiency of the Compound Locomotive —II.

At the conclusion of Mr. Dean's paper, read before the monthly meeting of the A. S. M. E., an abstract of which we published last week, the chairman, President Davis, called upon Mr. O. F. Nichols, chief engineer of the elevated roads of Brooklyn, where considerable experience has been gained with compound locomotives of the two-cylinder type. Speaking of the peculiar advantages of such locomotives for elevated road service, he said in part:

They appeal to the elevated railway from the practical standpoint of a lesser amount of dust and ashes, smoke, steam, etc., emitted, from the fact of using half the number of exhausts at considerably reduced pressures, certainly not more than one-half that of simple engines. The result is less trouble to people alongside of the road and less noise, in addition to the greater advantage of economy in fuel, which now has been thoroughly demonstrated in favor of the compound engine.

In 1890, I think, three engines out of seventy-five were changed from simple to compound. These three had been wrecked. They were originally Rhode Island engines. They were rebuilt by that works then and made two-cylinder compound engines, and those engines have been in continuous service ever since, running side by side with simple engines of the same class and capacity. The cylinders, which had been originally 11 inches in diameter, were made on the high-pressure side, 11½ inches in diameter, and the area of the low pressure was 2.4 times the area of the high pressure. Those engines had no increase in boiler capacity,

no increase in any of the parts, no material increase in the weights. The experience with these three engines was so satisfactory, for the reasons spoken of, that it led in 1892 to the construction of 19 other engines, all of them two-cylinder compounds, 16 of them built by the Rhode Island Works, and 3 built by the Pittsburgh Locomotive Works; the Rhode Island engines being the automatic engines that Mr. Dean has spoken of, that is, changing from simple to compound, and the Pittsburgh engines being of the non-automatic type, requiring to be changed from simple to compound. The old engines weighed, say, 24 or 25 tons. The new engines weighed 28 to 29 tons.

Comparing the new compounds with the old simple engines, the compounds reached full speed quicker than the simple. Our anticipation had been, and it had been predicted by opponents of the compound engines, that there must be trouble with compounds in this respect, that they would start more slowly and that they would come to a stop more slowly than simple engines. We noticed that the simple engines slowed down in 18 seconds and the compounds in 21. That was due largely to the fact that the compound engines were heavier than the simple engines were, and that they used the air brakes only and had not the Westinghouse brake. I think it is entirely attributable to that—that the engineers would hesitate with a heavy train to slow down for fear of causing disturbance to the passengers. The time of this run, which was 4 22 miles, was 22.8 minutes for the simple and 20.2 for the compound, or averaging 12.1 miles an hour, including 11 or 12 stops for the simple engine and 12½ for the compound. This speed was afterwards increased. When that run was increased to six miles it was determined to speed the engines up more, and an average of 15 miles, including the stops, was maintained with the compound engines, and we never did have a simple engine that would maintain that 15 miles an hour and make the 19 stops in the 6-mile run. That is partly due to the weight. I know that we are saving 20 per cent., and the Rhode Island expert, Mr. Batcheller, now deceased, who designed the engines, claimed and demonstrated to his satisfaction, and I think to mine, that he was making a saving of nearly 30 per cent. in fuel and in water, but I claim merely 20 per cent., and our average practice will show 20 per cent. saving, or it will show that those engines are annually saving 20 per cent. of the cost of the engines in the use of fuel and water, and that becomes very important particularly on elevated service where our fuel and water approximate to 25 per cent. of the total expenses of operation.

There was a great deal of criticism made as to these engines, and there was a time in 1893 when I am a little afraid the four-cylinder type was favored more than these. The effect was that the whole of these 19 engines were laid out of service upwards of six months. It was decided that they were not satisfactory and that they were giving us a great deal of trouble. There was a disagreeable jolt in starting and stopping those engines so as to disturb persons in their seats. A great deal of time and attention was given in trying to find out what that was attributable to. I never was fully satisfied in my mind what the trouble was. The fact, however, that these things did occur led to careful observation of it, and we came to the conclusion that the compound engine requires a great deal more care given to important details. It requires a great deal more care and attention in its repairs in keeping in order, and probably considerably more expense than the simple engine; that it requires—I speak now of these two-cylinder engines—it requires a great deal more care and skill in running, particularly in elevated railway service. I have seen runners make four and five stops without disturbing a passenger, and then on the sixth or seventh stop bring the train up with a jolt that would almost throw you on your head, showing at once, the engine being on the same run, that there must be a great deal of it in the individual runner, and that became so impressed on my mind that although I hesitated a long while about it, I was almost determined that it was very largely prejudice on the part of the men—that they were determined not to run those engines smoothly. That is a pretty severe accusation to make, I know, but it leads to this general result, from my standpoint, that I would not advise using compound engines in connection with simple ones, because if men become accustomed to one type of engine it is difficult for them to become reconciled to another type, and the simple engine requires a little less knowledge to understand. The runner does not need to know about the intercepting valve. The result is he avoids it and does not use his best efforts to make it do its best work. I have never heard or known of a case where the three original compounds, changed over from simple into compound, and, therefore, not specially designed as compounds, jarred a train, and those three compounds are running side by side with the simple engines, so I think it almost conclusive proof of what I said.*

In reply to a question by Mr. Geo. H. Platt, regarding the relative advantages of compounds on level and on roads with heavy grades, Mr. Dean said:

The engines between here and Scranton would have to run down hill considerably, and they would be burning coal while running down hill, and therefore they would not have the opportunity to be saving during that time. But on the other hand, while they were climbing the hills they would be saving more than they would if the road was like the Hudson River; so that possibly they might come to be saving fully as much, and I rather think more, than they would on a level road, because the compound produces marked saving in climbing hills.

In reply to an inquiry by Mr. G. C. Henning, Mr. Vauclain, general superintendent of the Baldwin Locomotive Works, said:

The locomotives upon the Pike's Peak Railroad were first constructed as single expansion engines. The road is about nine miles long. The maximum grade is 25 per cent. The minimum grade is about seven per cent. The engines did fairly good work. They were very well satisfied with them. But the consumption of water was enormous and also the consumption of coal, necessitating several stops for water and fuel and prolonging the duration of the trip. The business of the road, however, increased to such an extent that it became necessary to have another locomotive, and we built them a compound locomotive of the same capacity as the single expansion engine, and the economy in fuel was from 35 to 38 per cent. The consumption of water was between 25 and 28 per cent. less, necessitating one less stop for water and one less stop for fuel. The speed of the machine going up the hill was also increased. We reduced the time from about 2½ hours with the single expansion to 1 hour and 50 minutes with the compound engine. This performance was so satisfactory that after one year's use of the compound engine they arranged to have the three single-expansion engines returned to the works and converted into compound engines, and now the road is operated exclusively by compound locomotives, and they would have nothing else.

THE PRESIDENT: In this connection I would like to state that in the last number of *Locomotive Engineering* there is a record of a performance of a locomotive of the two-cylinder type which answers Mr. Platt's inquiries very fully. The road on which this engine spoken of in *Locomotive Engineering* was tested was a run of about 100 miles on the Chesapeake & Ohio Mountain division, of which the profile is very much the shape of a coarse tooth saw, and it gives the engine the greatest possible variety of work, excepting running on levels, and you can see by the article in that paper that the saving on all these kinds of service, freight, local passenger and express passenger, was very satisfactory. This engine, however, had one advantage that I have not heard mentioned before, that is, that it was enabled by being worked simple at will to carry a heavier load than would be possible otherwise. When they came to a very steep grade it could be used as a simple engine for the time being. That, of course, produced a greater economy per ton-mile by increasing the average load.

Mr. Vauclain said:

When I received the invitation from the committee to come here and speak for five minutes on compound locomotives, it was with considerable hesitation that I made up my mind to come. Being the patentee of one of the most extensively used systems of compound locomotives in this country, I have a slight hesitation in speaking about them before an association of this kind—I might be accused of taking advantage of the opportunity to advertise my wares. I naturally am favorable to the 4-cylinder compound. I do not wish you to understand that I take the position that 2-cylinder compounds are no good. I believe that a great deal of the trouble that we have experienced with the 2-cylinder compounds in locomotives in this country and abroad has been due somewhat to the faulty designing, and not sufficient engineering skill having been spent upon the designs when the engines were worked out. In this country locomotive builders are apt to take an order for a locomotive, and build it very rapidly. It is impossible to build satisfactory compounds upon a basis of that kind, unless you have gone through the experimental period, and understand exactly what you are doing, and know just what to use, and where to use it. The Baldwin Locomotive Works, of which I am general superintendent, have built over 500 4-cylinder compounds. We have built two 2-cylinder compounds. When we first introduced this system of engine, the particular style of valves that we used was very much cried down, and it was said that it would prove a total failure, and would interfere very much with what few chances the engine had of being a successful compound locomotive. It is this one point—the piston valve—upon which I cannot agree with Mr. Dean. We do not believe that there is any loss in using the piston valve due to the numerous apertures through which the steam has to pass, and the restrictions placed on the free passage of the steam by the bridges in the steam chest, because by using the piston valve we are able to get a very much longer length of port than with the ordinary slide valve, with very little valve friction. We are also able to operate steam pressures that it is utterly impossible to operate with the ordinary slide valve.

I cannot permit myself to speak of the numerous 2-cylinder compound locomotives that have been changed over to single-expansion engines, but in defense of the piston valve, I must necessarily speak of one, and that is on the Northeastern, of England. Mr. T. W. Worsdell was one of the greatest advocates of 2-cylinder compound locomotives, and he built a great number for that line; he has now been replaced by his brother; that railroad has found it necessary to change those engines to single-expansion engines. These very 2-cylinder compound locomotives are now being fitted with single-expansion cylinders, and those single-expansion cylinders are being fitted with piston valves, and indicator diagrams taken from those locomotives are far superior to any indicator diagrams I have seen taken from single-expansion locomotives with slide valves. If the length of port is sufficient, if the passage is free, so as to reduce the friction of the steam in passing from one cylinder to the other to a minimum, it seems to me it matters not whether you use a circular valve or a flat valve, and if by the use of a circular valve you reduce your friction to a minimum (much less than what you have in a flat valve), then it seems to me it is desirable to use the piston valve, and in a great many cases the piston valve can be used where it is utterly impossible to attach a slide valve.

One reason why we went into this system of compounding was that we had inquired thoroughly into the 2-cylinder system. The 4-cylinder system is used on the Paris, Lyons and Mediterranean road in France, and splendid engines those are, but very complicated. I was also in communication with Mr. Sigmund Cadena, now deceased, who was the chief superintendent of the Hungarian State Railway Engine Works, in Buda-Pesth, and he assured me that he had failed utterly to adapt the 2-cylinder compound to high-speed passenger service, and had to resort to the 4-cylinder compounds for the purpose, and found them very satisfactory. But for us to attempt to build an American engine, making it a 4-cylinder compound with tandem cylinders, or inside cylinders with crank axles, or anything of that sort, would not have done at all; we would not have been able to find a market for wares of that kind. The idea occurred to me that by placing the cylinders adjacent to each other, one immediately above the other, and connecting the two pistons to a common crosshead, supplying steam to both cylinders by a single piston valve, we could get very good results. If we would have losses in some direction, we would more than compensate for them by economies made in other directions. There would be no alteration to the locomotives, except to the cylinders, outside of the frames, and the guide and crossheads. The internal arrangements, the smoke box, the links, and everything of that sort would be exactly the same as on the single-expansion engines. Another valuable feature would be that it would be as well adapted to the very heavy decapod locomotive engines, weighing 200,000 pounds, equivalent to a 24x28 single-expansion engine, as it would be to an ordinary wharf rat used for ordinary street car service. It would also do for heavy freight service, and it would also answer for the very highest passenger service that we care to engage in in this country. It is this engine that has practically brought forth the very highest rates of passenger speed that we have had in this country. The Philadelphia & Reading Railroad are using the 4-cylinder compound exclusively for their fast Blue Line trains, between Philadelphia and Jersey City. The Central Railroad of New Jersey are using the 4-cylinder compounds for the same work, and fearing that perhaps the efficiency of these engines was due somewhat to the design of the boiler and other details, and not to the compound cylinders, other engines of the same type exactly, excepting that the single-expansion engine was given the advantage of 2 inches larger boiler, were built and placed in the same service, but they had no business with them—the compound engines are hauling the trains, the single-expansion engines are doing other work.

I might go on and give you numerous illustrations of this kind. We have over five hundred of these locomotives in service. We have made numerous tests. The economy ranges all the way from 10 per cent. up to 43 per cent. When you say 43 per cent. it seems like a very high economy, but it is due entirely to the anxiety on the part of the railway master mechanic to outdo the compound with his single-expansion engine. In this case that I speak of, where there was 43 per cent. economy, it was on a grade 12 miles long, 100 feet to the mile, with very heavy curves. The engines were loaded to their utmost capacity, the compound locomotive working full stroke worked very economically, whereas the single-expansion engine worked at a very great disadvantage, and not at all economically. I might add right here that in most of the 2-cylinder compounds the ratio of expansion between the two cylinders is from 2 to 2.5, very seldom getting beyond that. I believe the Pennsylvania has one compound that is a little higher, probably about 2.65 or 2.70. We aim at a ratio of 2.8 to 3. We prefer 1 to 3—rather 1 to 2.7—2.85, 2.90, and up to 3, most all of our compound engines average, which gives us a very economical expansion of the steam. We also find the engines very well adapted to elevated railroad service. In Chicago, the Southside Rapid Transit Company, which runs a gilt-edge high-speed service, has 45 of these com-

* In a letter subsequently received from Mr. Nichols, he says these compound engines were put in service again in the Fall of '94, and are now giving as good or better results than ever before.

pound locomotives in service, and one single-expansion engine. The single-expansion engine was first made a 2-cylinder compound in order to compete with the 4-cylinder. As we are builders of locomotives, and there being no monetary return to me whatever for my system of compounds, we aim to get the very best, whether it is a 4-cylinder or 2-cylinder compound, or 3-cylinder compound, or a single-expansion engine. We are in the locomotive business, and not in the compound business. But the trials of these engines on the Chicago Southside caused the company to have the 2-cylinder engine changed to a single-expansion when it could not compete as a 2-cylinder, and finally is used for switching service in the yard, and not run in regular train service.

In coming over this evening from Philadelphia, I happened to ride behind a 4-cylinder compound. We were a little late leaving Philadelphia. I timed the train mile after mile in 48 seconds to the mile with five vestibuled cars. It takes an extremely good engine to do that, especially with a small fire box burning anthracite coal. We have made exhaustive tests of what is commonly known as the Wooten fire box, fitted with compound cylinders, against the same engine fitted with single-expansion cylinders, and effected an economy of about 24 per cent. Another feature came out in these trials, and that was that the compound engine could burn a very much inferior grade of fuel, and the contrast was so great that now the Blue Line trains between New York and Philadelphia are using nothing but what is called Buckwheat coal, which costs the company about 35 cents a ton, whereas before they used the best quality of egg coal for the work. The Philadelphia & Reading operates 78 compound locomotives.

The lowest water rate per indicated horse-power that we have taken off has been at very slow speeds, say, from 60 to 80 revolutions per minute in freight service on the New York, Lake Erie & Western road, and those engines run as low as 17½ pounds of water per indicated horse-power per hour. That result was obtained, of course, by being able to get a very fine indicator diagram on account of speed. There was very little loss between the two cylinders, and the back pressure in the low-pressure cylinder was very slight. We have also noted in these trials that the most economical point of cut-off that we could find in a single expansion engine was about one-quarter stroke, and that was about 27 pounds of water per indicated horse-power. When we cut off at half stroke the water rate had very much increased, due to condensation and less expansion, and at the three-quarter stroke it was very much more so. At shorter cut-offs the increase in water rates was very much more rapid than when working beyond one-quarter stroke. In the compound engine we found a variation of about two pounds in the water rate between three-eighths and three-quarter cut-off, so that the indicator diagram has proved what we found in the tests, that the compound had a greater range of economy; that is, it could be worked at various points of cut-off and still be a very economical working engine, whereas the single expansion engines could only be worked economically at one-quarter cut-off, and when you departed from that you would have made up your mind to waste coal in order to get increased efficiency out of your locomotive.

I have this to say: we have made numerous tests of these engines. We have the tests in printed form, and anyone who takes a sufficient interest in the matter of compound engines and would address me at Philadelphia, I would be very glad to mail him all the literature that we have on the subject, and he can read it at his leisure and digest it.

The Secretary here read a communication from C. H. Quereau, Gen'l Foreman Motive Power Dep't B. & M. River Railroad. In this paper Mr. Quereau showed that he had made very careful and thorough tests of two compound and two simple locomotives, doing the same work under as nearly the same conditions as possible to obtain. A dynamometer car was used and the tests conducted in the manner recommended by the A. S. M. E.'s special committee. Tables of results were given showing that the compounds were more economical than the simple engines in the use of steam by about 15 per cent., boiler pressures being practically alike.

Some results of comparative tests on three other roads were given, in which, amongst other points, it was shown that repairs on compounds were rather less than on simple engines in same service. It was not stated whether the compounds were of the 2 or 4-cylinder type. A table given shows the following results in saving of fuel over simple engines:

	C. C., C. & St. L.	C., B. & Q.	C. & O.
Over average of all simple engines.....	23%	29%	25%
Over best simple engine record	12%	15%	16%

Mr. Quereau drew the following general conclusions:

1. There are compounds in service which are more economical in the use of coal and water than simple engines of the same dimensions and doing the same work in freight service.

2. The minimum economy of the compounds is not far from 15 per cent. It is probable that about two thirds of this economy is due to a better expansion of the steam, and about one-third to less loss by condensation.

3. The compounds have been in service too short a time to warrant final conclusions as to their cost for repairs, but the experience to date and theoretical considerations strongly indicate that this item will be no larger for the compounds than for the simple locomotives of the same dimensions and doing the same work.

The discussion then turned on the use of piston valves and their liability to leakage, Mr. Vauclain explaining the construction of his valve and maintaining that there was not usually so much trouble with it as with flat valves, especially at the high pressures used. In fact, he claimed in effect that steam was successfully handled by those valves at pressures that would make the flat valve very troublesome; and he was followed by Mr. Davis, Mr. Dean and others who gave instances of perfectly satisfactory working of flat valves at equally high pressures—especially of the Richardson balanced valves; Mr. Davis pointing out that in the compound engine the unbalanced pressure on the valve is much less than in the simple engine carrying steam at the same point in the boiler, because in the compound the receiver pressure is always below the high-pressure valve, and only the receiver pressure above the low-pressure valve. Therefore he did not see why a compound locomotive should not be able to use flat valves with very high initial pressure.

Mr. M. N. Forney called attention to the fact that there was a difference between fuel in railroad service and in saving money, and expressed hinself as being considerably in doubt as to the conclusions to be drawn regarding the balance for or against the compound, all things considered. Some tests he thought had been very unfair to the simple locomotive, especially where they had been used exclusively on grades, where the simple engines working against them had been obliged to use steam full stroke all the way, and consequently worked very uneconomically. He thought the simple engine usually had no friends interested in getting the best performance from it, and gave an instance in which Mr. Buchanan, of the New York Central, tested one of his engines of the famous 999 class (simple), and got results comparing very favorably with the best results with compounds. If he were building a simple engine to compete with compounds he would put the extra weight of the compound engine into a larger boiler, and thus increase the boiler efficiency.

Mr. Davis then spoke of the advantage of what he alluded to as the latest type of compound which could be changed to a simple engine at will. This he thought a very great advantage as it enabled a given engine to pull a load over grades or certain portions of the road which it could not otherwise pull, and thus increased the economically handled load on other portions of the road, when the tractive force required was within the capacity of the engine worked compound. This he thought was a legitimate advantage possessed by the compound principle.

Wages and Business.

The present upward movement of wages is, we think, almost if not quite unprecedented in this country during late years. A New York daily paper recently published a list of 230 establishments, employing about 128,000 people, in which wages had been recently advanced, and since that list was published there has been an advance in all the establishments comprised in the Carnegie iron and steel plants in and around Pittsburgh, this advance alone affecting about 15,000 employes. Very few of these advances have been otherwise than voluntary and upon the understanding that the business conditions warrant them, the Carnegie advance being made voluntarily in the face of an existing agreement which would have kept wages down for the balance of the year.

The good effect of this increased purchasing power of the masses of the people is manifesting itself by its effect upon business generally. The reports from the railroads are upon the whole encouraging, and while we look for no boom and hope there will be none, we do look forward with considerable confidence to an improvement in general business conditions.

South African American Exhibition.

News just to hand from South Africa informs us of an intended American Exhibition to be held in November, 1896, and for the benefit of American manufacturers and merchants, they should communicate with the secretary, Box 429, G. P. O., Cape Town, who will afford full particulars. South Africa is a growing country, and it may be worth while to investigate this matter.

Literary Notes.

SCREW PROPELLERS AND MARINE PROPULSION. By I. McKim Chase, M. E.

This is a practical and comprehensive work, treating on the principles of screw propellers, their peculiarities, various methods employed in their construction, and marine propulsion. Screws of various kinds are first taken up, defined and explained; then, the expanding pitch, and the measuring of the screw receive their share of attention. These chapters are followed by working drawings of screw propellers and their construction, patternmakers' preparations, sweeping up the propeller, making pattern of blade, and much other practical data. In the treatment of forms and dimensions of screw propellers, the author recognizes the fact that there is no problem in marine engineering in regard to which the opinions and practice of leading designers differ to a greater degree than in that of the screw propeller. While it is true that no formula exists by which the proportion of a screw may be determined which will give the best results in any given case, much has been learned by experience during the last decade, or thereabout. Practice has furnished examples so numerous, varied and accessible, that there is little difficulty in selecting a vessel whose performance has been satisfactory, and which can be used as a model, and by the method of comparison the proportions of a screw may be arrived at, which, if not absolutely the best for the intended vessel, will closely approximate thereto.

The author does not formulate any rules of his own, but simply gives the result of his experience, which has been extensive. He has also collated the results of numerous experiments, many of which have come under his own personal observation, and in cases where he has considered that they would enhance the value of the book, he has incorporated the description of the work done in that line. In the appendix will be found extracts from various works, but chiefly from those of Professor Rankine, whose rules relating to the paddle and the screw are as reliable as any that are to be found.

The different subjects are treated in a very comprehensive manner, many of them accompanied by useful tables, and all are illustrated by very good and clear engravings, among which we do not find a single catalog cut, the whole forming a very desirable addition to the literature of the screw propeller and marine propulsion. The book is published by John Wiley & Sons, 53 East Tenth street, New York. Price, $3.

THE MECHANICAL ENGINEER'S POCKET-BOOK. A Reference Book of Rules, Tables, Data, and Formulæ, for the use of Engineers, Mechanics, and Students. By William Kent, A. M., M. E., Consulting Engineer, Mem. Am. Soc. Mech. Eng'rs., and Am. Inst. Mining Eng'rs.

The appearance of this work is an event of great importance to the mechanical engineering profession and to all who have much to do with machinery. It is a new tool of daily and universal application and usefulness, and a necessity to every one who would be fully equipped for his work. The field of knowledge that must be commanded by the intelligent engineer of to-day is so vast that a ready, complete and reliable collection of information as to means and methods must be one of the greatest of labor savers. This book of over 1,100 pages, including the index, with only a few and only the most necessary cuts, with not a quarter of an inch of waste space, is, as we learn from the author's preface, a growth of twenty years of accumulation, and of four years of constant, and, as we know, exhausting labor in sifting and condensing. It is strictly up to date upon every subject, and we cannot find any topic of interest to the mechanical engineer that does not seem to be as fully and fairly treated as every other, while matters not strictly pertinent are excluded. The source and authority for everything is given in the fullest and most conscientious way, and the book is admirably indexed, so that, as a result, the matter that you want is in the book, you know where to find it at once, and where it came from and what it is worth, and if you wish to follow up any matter further, the authorities cited will suggest the fields for further investigation. Published by John Wiley & Sons, New York. Price, $5.00.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON AERIAL NAVIGATION. Held in Chicago, August 1, 2, 3 and 4, 1893.

This book contains a full report of the papers and addresses presented at the International Conference at Chicago. The authors of these papers are men eminent in the profession, or experienced engineers, or both, who by reason of their knowledge and training gave a high character to the papers which undoubtedly will be of great interest and value to all who are concerned in the subject of aërostation. There are thirty-five papers covering a wide range of subjects, including reports of experimental investigation, facts and positive knowledge relating to problems in aëronautics and aviation. Discussions of some of the papers are given in the appendix. The book contains 429 pages, including a good index. It is published at the office of *The American Engineer and Railroad Journal*, 47 Cedar street, New York. Price, $2.50.

STEAM POWER AND MILL WORK. PRINCIPLES AND MODERN PRACTICE. By George William Sutcliffe, Whitworth Scholar, Member of the Institute of Civil Engineers.

The aim in this work has been to give an account of modern practice for the consideration of those interested in the manufacture, control and operation of boilers, engines and mill work. The leading principles and calculations affecting such work also receive a share of attention. A large part of the work is devoted to descriptive matter, and useful hints and information for the designer engaged in mill work and steam engineering. In our opinion, much of the descriptive matter could with advantage have been condensed, and replaced by good

illustrations. The author claims that special attention has been paid to simplicity of treatment of mathematical questions. This is true, but unfortunately so much data for the proof of the assertions made has been omitted that the mathematical treatment of questions is not liable to inspire much confidence. There is much in this work which can be commended, but there is also much which can be improved by a thorough revision. Books which are now placed in the field of competition must be superior in the treatment of subjects and better illustrated than the many good books treating on the same subjects, and which are now in use.

The work is published by Macmillan & Co., 66 Fifth avenue, New York. Price per copy, $4 50.

BOILER INCRUSTATION AND CORROSION. By F. J. Rowan. New Edition. Revised and partly re-written by F. E. Idell, M. E.

This little work treats upon one of the most important topics that can engage the attention of the steam engineer, involving in fact the efficiency and the life of the steam boiler. Considerable information has been collected upon the subjects treated, and the practical man may be able to sift it out. Van Nostrand's Science Series No. 27. Price, 50 cents.

We have received Shepard's "Horse-power Scale," published by the *Marine Review*, Cleveland, Ohio. This is a compact arrangement for the pocket, by the aid of which one may readily know almost any particular that is most commonly to be known about a steam engine. Upon one side, between folding covers, is a diagram with lines showing the temperatures of saturated steam by pressures varying by intervals of five pounds up to 200, also the total heat in steam and the density or weight of steam for the same pressures. From the same diagram may also be ascertained the mean effective pressure for given point of cut-off and pressure, and the water consumption per hour. Upon the opposite cover are mounted graduated disks, which upon adjustment to the known data, give the size of cylinder, revolutions, piston speed, mean pressures, horse-powers, and the ratios of compound cylinders. The arrangement is compact, handy, labor and time-saving, and, as far as we have tested it, reliable.

We have received from the secretary and treasurer, W. A. Sheehan, Galesburg, Ill., a souvenir of the Brotherhood of Railroad Trainmen, which contains an interesting account of the fraternity, with portraits of its officials, and interior views of the offices in which its work is carried on and its journal published. It is very finely gotten up, and is standard size, 6″x9″.

We are in receipt of a pamphlet reprint from the *Journal of the Association of Engineering Societies*, containing the presidential address of Mr. Ambrose Swasey. His subject is "The Specialist in Engineering," and, as might be expected, it is ably, though briefly, handled.

A Fixed Standard.

If by legislation we should decree that our standard inch should be reduced in size 50 per cent. every lathe and planer would immediately be able to run twice as many inches per minute as before. But every practical man knows that we could not do any more work than before. Just as much sweat, toil, skill, and wear and tear would have to be expended in building a machine, no matter what the standard by which it is measured.

It would seem to be the same with money, which is only a standard for comparison of values, and a convenience. If our present half dollars were by law decreed to be dollars, our machine when finished might sell for twice as many dollars, but it would require to build it just as much labor as before, and the increased number of dollars received for it would be exchangeable for just as much and no more of the products of other men's labor. But in all changes of the standard of value, working men, and, in fact, all those who do not make a special business of finance, suffer losses which they cannot defend themselves against, and it seems to us that the interests of the masses of the people, workingmen, merchants and manufacturers, lie in the direction of a fixed and unchanging standard by which to estimate values.

Among the summer courses of study at Cornell University, a schedule of which is before us, we note some that should be specially interesting to engineers and mechanics who have not time or opportunity for a full course in engineering, yet are in need of special instruction, or to become familiar with methods of testing, or the principles of machine design, or to take a course in mechanical drawing. Full particulars can be obtained by addressing Prof. G. B. Preston, Cornell University, Ithaca, N. Y.

Col. Albert A. Pope, of Boston, has evidently not lost his interest in the beneficent good roads movement, and he issues a circular letter in which he tells of what has been accomplished in Massachusetts and how it was accomplished. It should be in the hands of all who are in a position to help on the work of civilization by good road building.

Turrets of elliptical form for battleships are the latest development. Naval Constructor Stahl, U. S. Navy, being the originator of the idea. Turrets of this form are said to be much superior in points of weight for a given gun room and in reduction of size of target offered by them.

Mr. F. H. Brown, of New York City, who was for some time connected with the London office of Ldw. Loewe & Co., is now traveling in this country in the interest of Wm. Sellers & Co.

NEW CATALOGS.

The Buda Iron Works, Buda, Ill., send us a catalog illustrating and describing their patent light steel wheels for hand and push cars, railway velocipedes, and street cars.

We have received from the Whiting Foundry Equipment Co., 1522 Monadnock Building, Chicago, Ill., a pamphlet devoted to the illustration and description of trucks and turntables, and general tramway equipments, intended especially for use in foundries and industrial plants generally.

We have received from C. H. Baush & Sons, Holyoke, Mass., a catalog devoted to the illustration and description of various forms of radial drills, spining machines, horizontal boring, milling and drilling machines, multiple-spindle drilling machines, cam milling machines, etc. It is standard size, 6″x9″.

By the courtesy of Prof. Wm. F. M. Goss, of the Purdue University, Lafayette, Ind., we are in receipt of the Annual Catalog of the University for 1894-5. An inspection shows a very satisfactory condition of this well-known school, especially in view of its recent misfortune by fire, which was noted in our columns at the time.

We have received from the Continental Iron Works (Greenpoint) Brooklyn, N. Y., a catalog containing illustrations of the Morison suspension furnaces for marine and land boilers, and the Morison patent furnace door and frames. The catalog also contains rules for calculating the pressure allowable on these, or Fox corrugated furnaces, rules for finding the thickness of metal, and information useful to those interested in work of this class.

We have received from the Philadelphia Engineering Works, Philadelphia, Pa., a catalog devoted to the illustration and description of steel plate chimneys made by this concern. It contains a number of fine illustrations of such chimneys, with full particulars of sizes and proportions, and there is also much other useful information of a general character pertaining to the subject. This catalog could easily be trimmed ¼″ smaller one way, and ⅛″ smaller the other, and it would then be standard size, 6″x9″.

Messrs. Rawson & Morrison, Cambridgeport, Mass., send us a large and finely gotten up catalog illustrating and describing their patent friction hoisting engines, which are intended for contractors' and similar uses, stationary engines and steam boilers, automatic coal-handling machinery, steam fertilizer dryers, hydraulic pumps and presses, rendering tanks, lard coolers, steam heaters, baling presses, water tanks, conveyers, and general machinery. Full particulars are given, and the catalog will be found a valuable one.

We have received from the Norton Emery Wheel Co., Worcester, Mass., a catalog devoted to full illustration and description of the Walker universal tool and cutter grinder. The illustrations comprise a large variety of operations which can be performed by this grinder, and much interesting information is contained in the catalog, which is sent upon application. Accompanying it is a table of decimal equivalents, and of equivalents of metric and English measurement, which should be found useful in the shop and drafting room.

Chas P. Willard & Co., 197 So. Canal street, Chicago, Ill., send us "Catalog No. 29," which is de-

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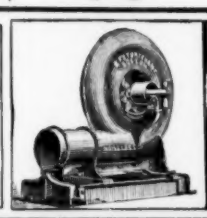

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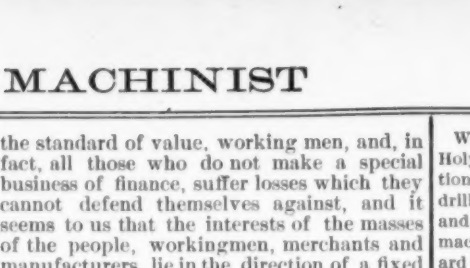

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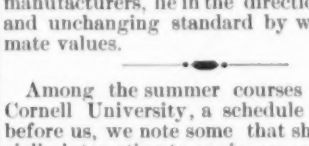

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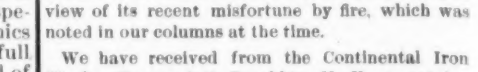
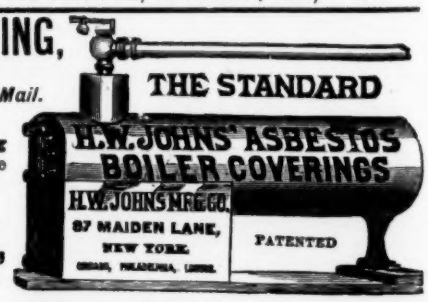


"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
SOLE REPRESENTATIVES IN THE UNITED STATES.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

ARE YOU LOOKING
for a lathe? We are building them in various sizes from 9″ to 24″ swing, in various lengths, both engine and speed lathes. Our designs are the **latest**, while the **workmanship, material** and **finish** are of the **highest** order. Our catalogue will tell you all about them, as well as of our planers, shapers and other tools. A postal will bring it.
SEBASTIAN LATHE CO.,
117 and 119 Culvert St., CINCINNATI, OHIO, U. S. A.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.



voted to illustrations and descriptions of small yachts, launches, and machinery for same, including boilers, engines, paddle-wheels, screw propellers, etc. It will be found of interest to those who have to do with the navigations of harbors, rivers, and the lakes. By trimming $\frac{1}{8}$ of an inch off from the hight of this catalog, which, it seems to us, could very easily have been done, it would then have been standard size, 6″x9″.

The B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass., send us a new "Sectional Catalog No. 85." This has 20 pages, and is issued preliminary to a general treatise of the subject of mechanical draught. It contains a number of illustrations of arrangements for forced draught, using various forms of Sturtevant fans and engines, and there is also an extended list of users of the apparatus. The catalog will be found interesting to those who wish to investigate this, one of the latest developments in engineering.

MANUFACTURING.

The mill of the Kaukauna (Wis.) Paper Co. is to be enlarged this summer.

The Worcester Gear Works, of Worcester, Mass., has been organized recently by Josiah Brown.

Park Bros. & Co., of St. Louis, Mo., will erect a new steel mill to replace the one burned lately.

The Jarman Mechanical Engineering Co., of Durham, N. C., will soon be organized to erect shops.

The Milwaukee (Wis.) Incandescent Lamp Co. has been incorporated. W. J. Reilly is interested.

The Centreville (La.) Lumber Mfg. Co. has been organized, with a capital of $50,000. V. Schwan is president.

The National Foundry and Machine Co., of Louisville, Ky., will erect a machine shop this summer. It is to be 120 by 50 feet.

A double band-saw mill is to be erected at Raceland, La., at a cost of $60,000. D. J. Murray is at the head of the scheme.

The Central Cycle Co., of Kansas City, was recently organized. The incorporators are Geo. B. Wing and L. L. Hutchinson.

The Abenaqui Machine Works, of Walpole, N. H., have been incorporated, with a capital of $60,000, and will soon build a plant.

The Edgefield (Ky.) Cotton Mfg. Co. has been formed, with a capital of $100,000. Among the incorporators is Alvin Hart.

J. H. Cameron and O. W. Hart, of Fall River, Mass., propose to organize a stock company for the manufacture of cotton gins.

D. J. Murray, of Warsaw, Wis., has arranged for the erection of a double band-saw mill. The machinery will cost about $50,000.

A company has been organized to build a cotton-mill in Belton, Texas, with a capital stock of $100,000. N. K. Smith is interested.

The Great Western Smelting and Refining Co. will occupy the building vacated by the Gates Iron Works on South Clinton street, Chicago.

It is said that Frederick T. Lockland, of Augusta, Ga., is at the head of a concern which intends to build a railroad at Reidsville, Ga.

The Saugerties (N. Y.) Mfg. Co. has been incorporated, with a capital of $225,000. Among the directors are O. G. Greenleaf and E. C. Rogers.

Mr. John Platt, M. E., Consulting Engineer, and specialist in hydraulic machinery, has removed his office from 136 Liberty street to 97 Cedar street, New York.

We learn that Wm. Sellers & Co. are quite busy in their crane department, but we hear of no builders of heavy tools that are as yet feeling much of the effect of the revival of business.

Messrs. Jenkins Bros., 71 John street, New York, have taken a novel method of informing engineers what their Jenkins' packing is like, by simply attaching a section of it to a card and mailing it to all applicants.

The New York headquarters of the Cleveland Twist Drill Co. have been removed from 102 Reade street to 99 Reade street, New York City. Mr. C. I. Markham has been placed in charge, and will carr a new and complete stock of drills and kindre tools.

The additions to the plant of the Westminster Paper Co., Bellows Falls, Vt., are completed. The new machine room is 40 feet wide and 185 feet in length, covered with one of the Berlin Iron Bridge Company's patent anti-condensation corrugated steel roofs.

Machinists' Supplies and Iron.

NEW YORK, May 18, 1895.

Iron—American Pig—We quote standard brands, $12 to $12.50 for No. 1; $11 to $11.25 for No. 2, and $10.25 to $10.50 for No. 2 Plain. Southern brands, $11.25 to $11.50 for No. 1; $10.75 to $11 for No. 2; $10.25 to $10.75 for No. 3; $10.75 to $11 for No. 1 soft; $10.50 to $10.75 for No. 2 soft; and Foundry No. 4, $10 to $10.25.

Antimony—The market is firm, and some of the prices have advanced. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8¾c.; Hallett's 7.10c. to 7½c., U. S. French Star, 7½c., and Japanese, 7c. to 7½c.

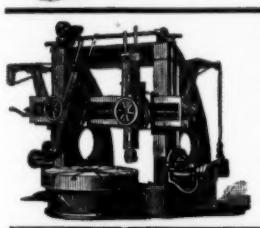
Lard Oil—Prime City we quote at 51c. to 52c.

Copper—The market is strong, the consumption is heavy, and prices have advanced. Lake Copper has been sold at 10¾c., but holders are now asking 10¾c. Casting Copper is held at 9¾c. to 10c.

Lead—The market is stronger than it has been, prices have advanced, and considerable business has been done. For New York delivery 3.27½c. is quoted.

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

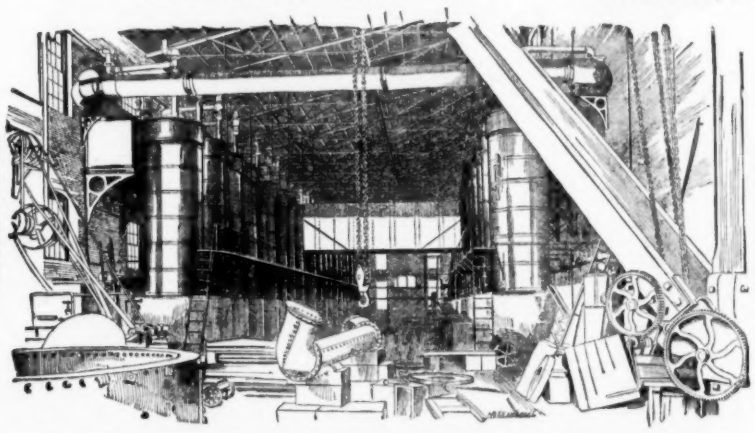
NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.



BORING AND TURNING MILLS
COMBINING EVERY IMPROVEMENT.
14 SIZES FROM 5 TO 20 FEET.
BETTS MACHINE COMPANY,
WILMINGTON, DEL.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of

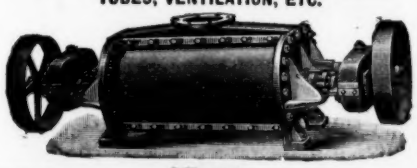


Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the interior of a Boiler House, the roof of which was designed and built by us for the Amoskeag Mfg. Co., at Manchester, N. H. The building is 75 feet in width by 275 feet in length, the walls being made of brick, and the roof being made of iron—iron trusses, iron purlins—and covered with corrugated iron, so that there is absolutely no woodwork anywhere about the building which can take fire. For boiler rooms this construction particularly commends itself.

SEND FOR OUR ILLUSTRATED CATALOGUE.

ROOT'S FORCE BLAST ROTARY BLOWER.
For FOUNDRIES, SMITH SHOPS, PNEUMATIC TUBES, VENTILATION, ETC.

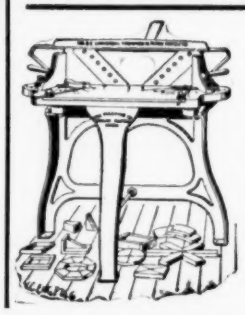


SLOW SPEED, POSITIVE BLAST, PERFECTLY BALANCED.

BEST MECHANICAL CONSTRUCTION.

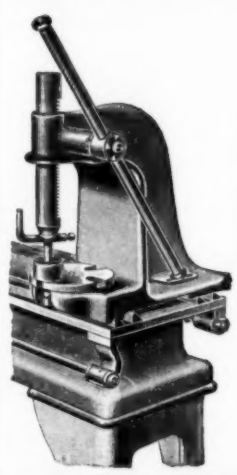
P. H. & F. M. ROOTS, Manufacturers,
CONNERSVILLE, IND.
Chicago Office: 1405-10 Manhattan Building.
COOKE & CO., Selling Agents,
163 & 165 Washington St., NEW YORK.
In Writing Please Mention This Paper.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.



THE NEW FOX
Universal Trimmer
is the only one that has an accurate adjustment of the gauges. Cannot be set wrong. Work must be correct. Time saved in Pattern-making and all wood-working.
CATALOGUE FREE!
FOX MACHINE CO.,
325 Nor. Front St., Grand Rapids, Mich.
136 Finsbury Pavement, London, England.

The Greenerd Arbor Press.



PATENTED DECEMBER 1, 1891.
For Sale at Manufacturers' Prices by
A. J. WILKINSON & CO.
180 to 188 Washington Street,
BOSTON, MASS.
Send for Descriptive Circular.

CALIPER SQUARES
Any Style or Graduation.
(5 Sizes, Metric and Vernier System.)
NONE BETTER.
Send for Catalogue and Special Prices to
E. G. SMITH, Columbia, Pa.

C. W. LE COUNT,
SOUTH NORWALK, CONN.

REDUCED PRICE OF LE COUNT'S HEAVY STEEL DOG

No.	Inch.	Price.
1	3-8	$ .40
2	1-2	.50
3	5-8	.68
4	3-4	.88
5	7-8	.92
6	1	.92
7	1 1-8	.92
8	1 1-4	.92
9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.25
Full set of 19		$21.60
20 (ext.)	5 1-2	4.00
21 (ext.)	6	5.00

This Dog has a Very Heavy Bone, so that if the thread wears a Heavier Screw can be substituted.

When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.

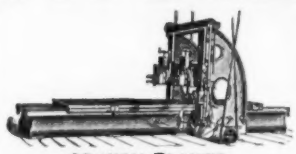
Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.

One Small Set of 8—by 1-4 inches to 20 inch, - - $6.25
One Set of 12—by 1-4 in. to 2 in. continued by 1 2 in. to 4 in. 13.25

These goods are for sale by CHAS. CHURCHILL & CO., L'td, 21 Cross St., London, England.

Star Foot-power Screw Cutting Lathes Automatic Cross Feed
9 and 12 inch Swing.
New Designs. Novel Features.
Send for Catalogue B.
SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N. Y.

FITCHBURG TOOLS.



48-INCH PLANER.

PLANERS AND MANY MORE MODERN METAL MANIPULATING MACHINES
MANUFACTURED BY
FITCHBURG MACHINE WORKS, FITCHBURG, MASS.
GOOD 2d HAND TOOLS.

BUILDERS IRON FOUNDRY,
FOUNDERS AND MACHINISTS,
PROVIDENCE, R. I.
We can guarantee that our castings will be uniform and of high tensile strength.
Tensile strength of ten specimens taken from an air furnace heat:

34,260 lbs.	34,390 lbs.	32,600 lbs.	33,200 lbs.	34,400 lbs.
36,420 "	34,650 "	32,460 "	36,550 "	36,700 "

JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

Mess. HOUGHTON & RICHARDS, Boston, Mass.
Gentlemen:—I must say that in 25 years experience with all kinds of Tool Steel I have never found a steel to compare with your Styrian Special Brand. We have planed hard steel dies with it that we could not get any other steel to cut, and the tool was scarcely dulled in doing it. Yours truly,
SPRINGFIELD DROP FORGING CO.,
A. L. MOORE, Treas.
HOUGHTON & RICHARDS,
SOLE AMERICAN AGENTS,
148 & 150 OLIVER ST., BOSTON.

WORTHINGTON CONDENSER.
ONLY APPARATUS that can MAINTAIN a VACUUM on ENGINES and ELEVATE the discharge WATER to TANK at any height.
This feature is appreciated by PAPER MILLS, SUGAR REFINERIES, COTTON and WOOLEN MILLS.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St. BOSTON, 70 Kilby St. PHILADELPHIA, 607 Arch St. CLEVELAND, 24 South Water St. CHICAGO, 185 to 189 Van Buren St. ST. LOUIS, Eighth and St. Charles Sts. INDIANAPOLIS, 64 South Pennsylvania St.

Spelter—The market shows considerable improvement,. and the demand by consumers has been liberal. For New York delivery 3.55c. is quoted.

Tin—The market is stronger, prices have been as high as 15¼c., but receded to 14.9°c. for prompt delivery; for futures 14.90c. to 14.95c. is quoted. Although the market was fairly active, dealings were not as large as expected.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec'a; good commission. Mfr., 1115 State St, Erie, Pa.

Wanted—An exp'd duplex pump salesman. Address, giving particulars, Duplex Pump, Am. Mach.

Young M. E. with exp. wants pos. as designer of steam engs. or gen. mach. Box 185, Am. Mach.

Wanted—By a first-class young molder, a situation. Address R., care American Machinist.

Young machinist wants pos.; good machine hand. H. E. Beck, 855 Driggs Ave., Brooklyn, N. Y.

Wanted—By young mach., work at tool-making under instructions; small pay expected. Box 183, American Machinist.

Wanted foremanship, by one having a wide experience with general jobbing; generators, dynamos, and engines. Indicator, care Am. Machinist.

Wanted—Position by a steady temperance young man, as layer out in boiler shop. Best of reference. Address H. N. Mc., care of American Machinist.

Mech. draftsman embarking in the brok erage and commission bus. wants manufactories to represent in Cincinnati and Ohio. P. J. C., 77 W. Fourth St., Cincinnati, Ohio.

M. E. special and hyd. mach. design, tech. education, desires pos. in New England or New York. Box 196, American Machinist.

Mechanical eng., age 29, grad., rapid and accurate designer, exp'd mach., and as manager of men, wishes change. Reliable, Box 197, Am. Mach.

Wanted—Energetic, reliable men, acquainted with high-class mechanics and inventors; no canvassing. Edwin Guthrie, Washington, D. C.

An energetic man to represent us in N. Y. City; one connected with the boiler or steam pipe business preferred. Holly Steam Engineering Co., 344 Butler Exchange, Providence, R. I.

Blacksmith, situation by married man, age 33, 15 yrs. exp., well up in mach'y, blacksmithing and forging, with some exp. in handling men. Box 683, American Machinist.

Competent mech'l engineer wants responsible position. 15 years exp. on hoisting mach'y. Steam, water power, and electric mach'y. Best refs. from concerns of highest standing. Box 195, Am. Mach.

Wanted—At once, foreman mach. for mill. mach. shop; one acquainted with roll corrugating, and who can make shop sketches pref'd. State age, nationality, wages, etc. W. E. Caldwell Co., Louisville, Ky.

Patternmaker who knows his business, is 12 yrs. foreman in present pos., wants a change; would take pos. as instructor in trade school. Box 191, American Machinist.

Wanted—A 1st-class draftsman, familiar with designing high duty pumping machinery of the most modern design. Give age, exp. and ref., and state salary expected. L. D. G. Co., Cincinnati, Ohio.

Wanted—A good blacksmith as tool dresser for a large machine shop, who thoroughly understands his business. When writing, give age, references, and whether married or single. Address Box 190, care American Machinist.

Wanted—An energetic foreman for a mfg. machine shop; must understand pushing productions and handling help, as well as building mach'y. A self-reliant man with a record preferred. State age, exp. and salary expt'd. Box 186, Am. Mach.

Working foreman wanted as ass't to mechanical supt. of factory manufacturing buggy axles and springs; must be exp'd in axle work, capable of taking charge of works. State age, experience and salary expected. Box 188, Am. Machinist.

Wanted—A working foreman for a foundry working 3 or 4 men in Southern Texas. Must be well up in modern practice of brass and iron founding; applicants to receive attention must give references and salary required. Address Moulder, American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

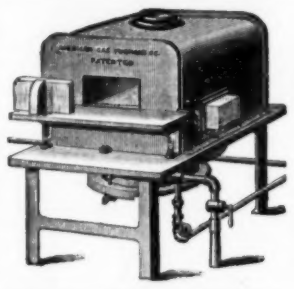
For Sale—Three sets of cane mill patterns, nearly new. Also several engine patterns. Address Walker, Madison, Ind.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

Wanted—A set of tracings or blue prints for ten ton electric crane, 40-foot span. Reply, with prices and details of type, to Box 189, American Machinist.

Wanted—At once, back numbers American Machinist, issues of April 23d and May 14, 1891, April 7, 14, 21, 28, and October 13, 1892, must be in good condition, state price. Box 194, Am. Mach.

For Sale or Trade—Complete plant, foundry, machine shop, tools and stock (established 10 yrs, and paid good dividends) in one of the best agricultural States of the West, making a specialty of grain elevator and mill mach'y, and in close proximity to mining districts. Good railroad facilities. Address W. 2, care American Machinist.



AMERICAN GAS FURNACE CO.,

Oil Gas Plants

GAS BLAST FURNACES AND HIGH PRESSURE BLOWERS

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

No. 80 Nassau St., NEW YORK.

English Agency: {Chas. Churchill & Co., Ltd., 21 Cross St., Finsbury, London, E. C., England.

CLEVELAND TWIST DRILL CO'.S GRIP SOCKETS.

No More Twisted Tangs.

Larger drills can be used with smaller shanks than ever before.

No charge for the groove in the shanks.

Send for Descriptive Price List.

Cor. Lake and Kirtland Sts., Cleveland, Ohio.

SPECIAL SALE OF New Planers

At our Chicago Store to reduce stock.

EVERY PLANER OFFERED IS A BARGAIN.

One Flather Planer, 22" x 22" x 5 ft.
One Draper Planer, 26" x 25" x 6 ft.
One New Haven Planer, 24" x 20' x 4 ft.
One New Haven Planer, 28' x 24" x 7 ft.
Two New Haven Planers, 34" x 30" x 8 ft.
One Smith-Silk Planer, 24" x 24" x 6 ft.
One Smith-Silk Planer, 24" x 24" x 7 ft.
One Smith-Silk Planer, 27" x 25" x 6 ft.
One Smith-Silk Planer, 30" x 30" x 10 ft., with two heads.
One Smith-Silk Planer, 36" x 31" x 18 ft., with two heads.

HILL, CLARKE & CO.,
Machinery Merchants,
12 & 14 S. Canal St., CHICAGO, Ill.

BETTER, HANDIER, LIGHTER, CHEAPER, STRONGER, THAN ANY COMPETITOR

BONANZA OIL CUP

WILL WORK

UP SIDE DOWN

Rightside up OR in any position

Suitable for HELMET OIL

Charles H. Besly & Co.
FINE TOOLS
SUPPLIES FOR MF'RS METAL WORKERS ETC.
Chicago, Ill. U.S.A.

LARGE TOOLS

At special low prices before removal.

PLANER, 64 in. wide, 64 in. high, 10 ft. long. Good order, "Pond's make."

PLANER, 60 in. wide, 60 in. high, 20 ft. long. Good order, heavy pattern, "Steam Eng Co.'s make."

PLANER, 36 in. wide, 33 in. high, 14 ft. long. Good order, "modern style."

PLANER, 30 in. wide, 30 in. high, 10 ft. long. Good order, "Harrington's make."

LATHE, 72 in. swing, 20 ft. bed, triple geared, screw feed and compound rest. Good order.

LATHE, 43 in. swing, 16 ft. bed, triple geared, screw feed, compound rest, cross feed and chuck jaws, "N. Y. Steam Engine Co.'s make."

LATHE, 24 in. swing, 14 ft. bed, rod and screw, cross feed and chuck, "Lathe & Morse make."

HAPER, traveling head, 14 in. stroke, 28 in. feed, centers, circular feed and chuck, "Fitchburg make."

SLOTTER, 18 in. stroke, extra heavy, full automatic feeds, "Bement's make."

HOR. BORING AND DRILLING MACHINE, large size, "Sellers' make."

BOILER ROLLS, 10 ft. with hinged housing, improved style. Good as new.

J. J. McCABE,
SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.
14 Dey St., NEW YORK.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.
14 in. x 4 ft. Blaisdell, Taper.
16 in. x 6 ft. Perkins, Taper.
16 in. x 8 ft. Perkins, Taper.
16 in. x 8 ft Blaisdell.
18 in. x 10 ft. Blaisdell.
28 in. x 20 ft. Perkins.
37 in. x 14 ft. maker unknown.

PLANERS.
16 in. x 16 in. x 4 ft. Hendey.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 5 ft. Putnam.

SHAPERS.
10 in. Pratt & Whitney.
12 in. Juengst, Crank.
15 in. Juengst Friction.
10 in. Wood and Light Traverse Head.
18 in. Putnam, Traverse Head.
18 in. Smith & Silk, Crank.
21 in. Smith & Silk, Shifting Belt.
20 in. Gould & Eberhardt.
24 in. Hendey, Friction.

DRILL PRESSES.
No. 1 Two Spindle, Garvin.
No. 2 Three Spindle, Garvin.
No. 2 Four Spindle, Pratt & Whitney.
No. 3 Six Spindle, Garvin.
20 in. Snyder, Wheel Feed.
24 in. Blai dell Wheel Feed.
24 in. Aurora, Back Geared.
30 in. Pond, Back Geared, Power Feed.
9 ft. Holly Mfg. Co., Radial.

SCREW MACHINES.
No. 1 Garvin, Wire Feed.
No. 5 Brown & Sharpe.
2 No. 1 Brown & Sharpe, Wire Feed.
1 Brown & Sharpe, Automatic.
No. 2½ Pratt & Whitney.
No. 3 Garvin, Back Geared.

MILLING MACHINES.
No. 2 Pratt & Whitney, Lincoln.
1 No. 20 Garvin, with arm.
1 No. 21 Garvin, with arm.
No. 0 Garvin Universal.
No. 1 Garvin Universal.
No. 3 Garvin Lincoln.
No. 2 Garvin Duplex.

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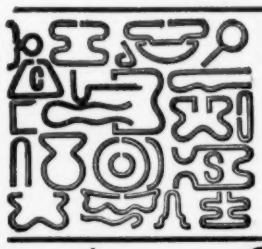

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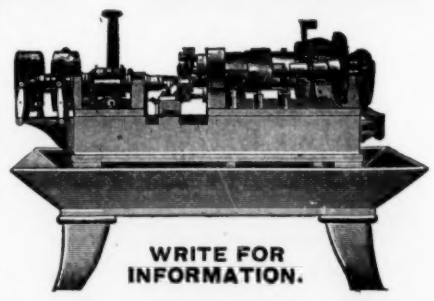

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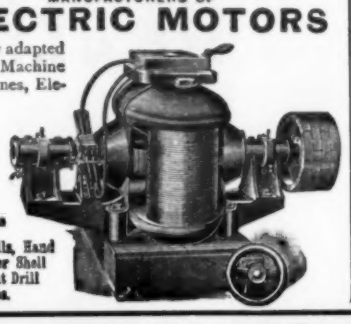

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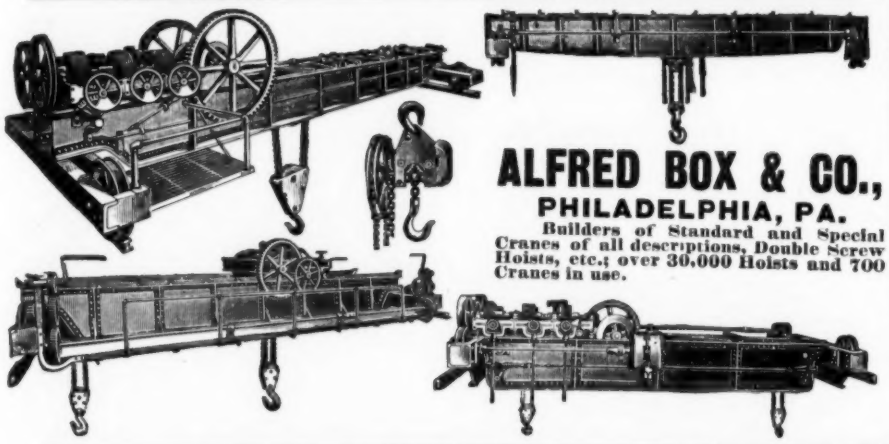

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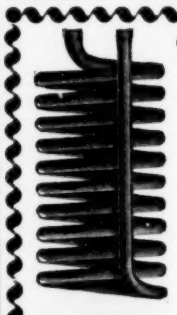

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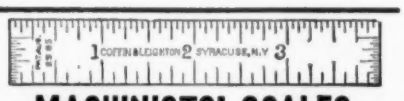

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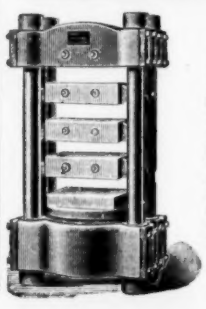

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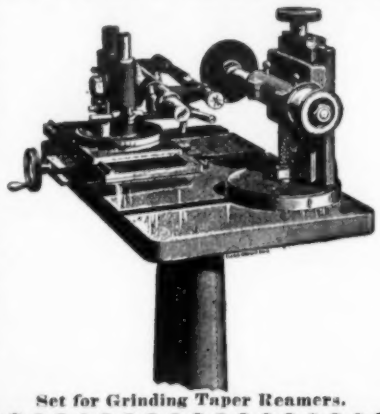

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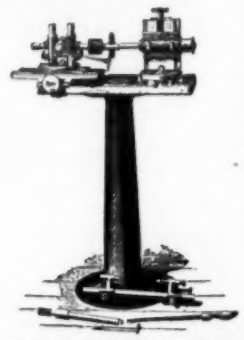

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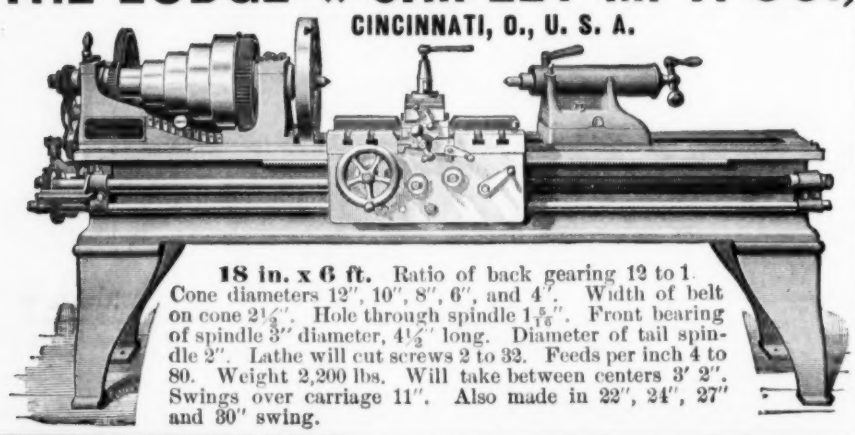

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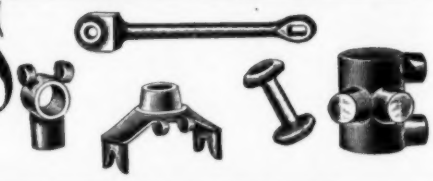

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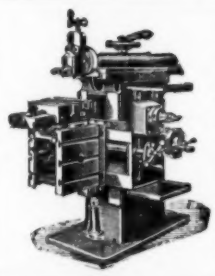

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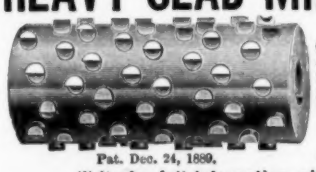

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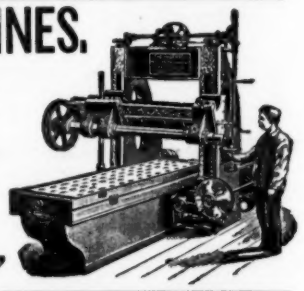

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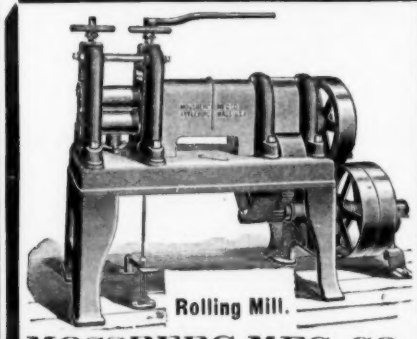

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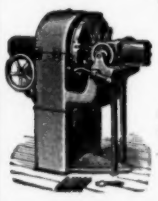

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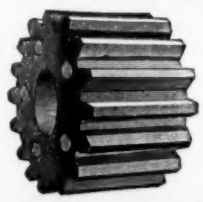

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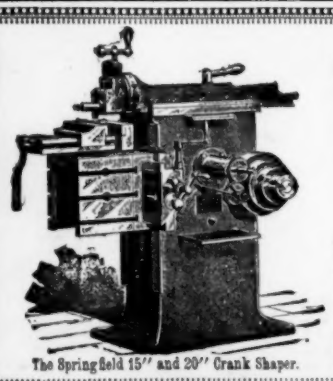

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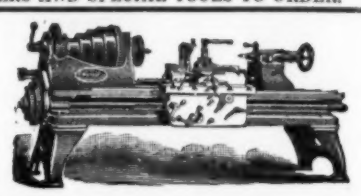

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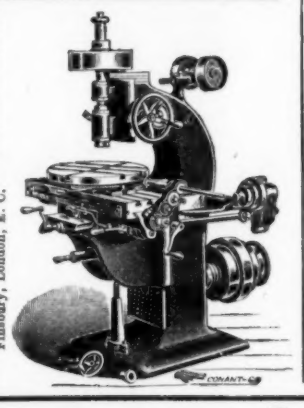

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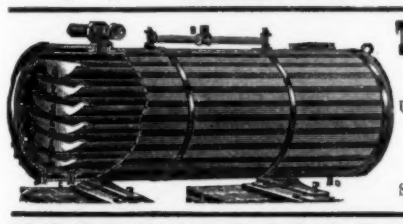

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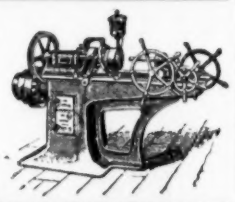

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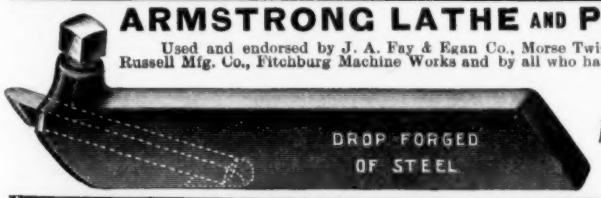

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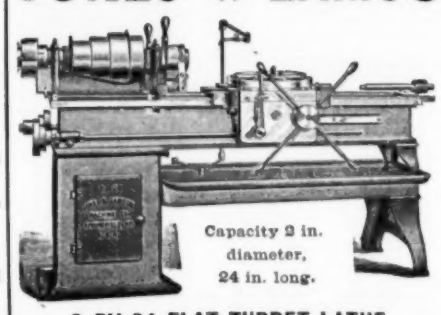

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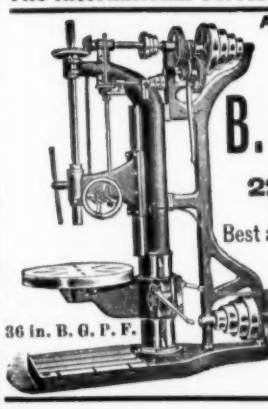

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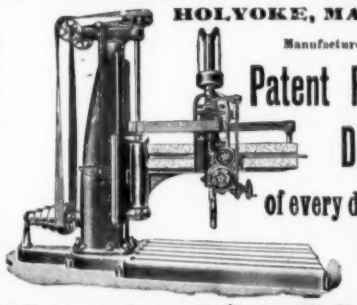

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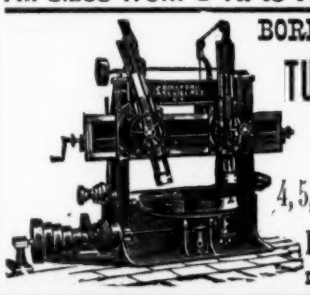

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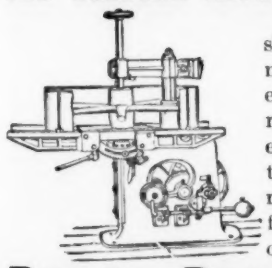

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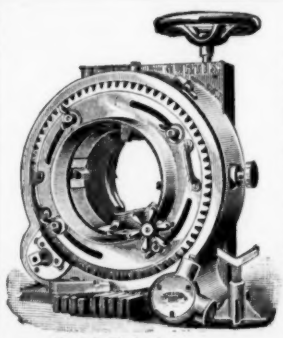

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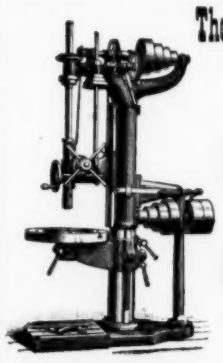

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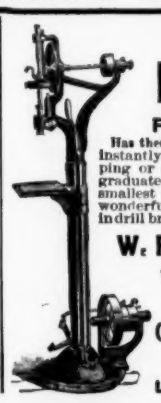

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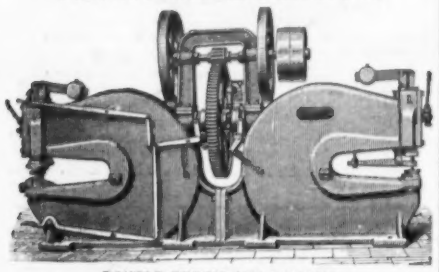

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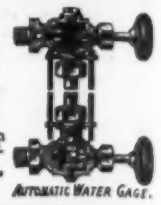

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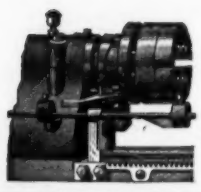

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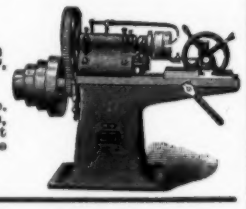

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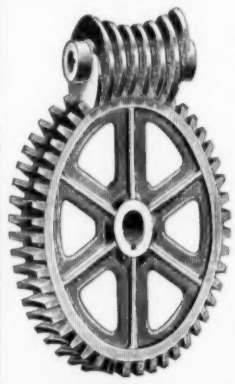

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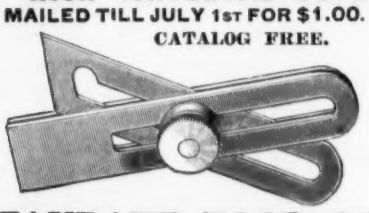

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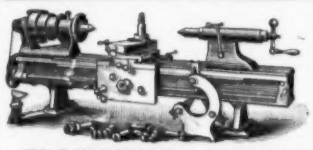

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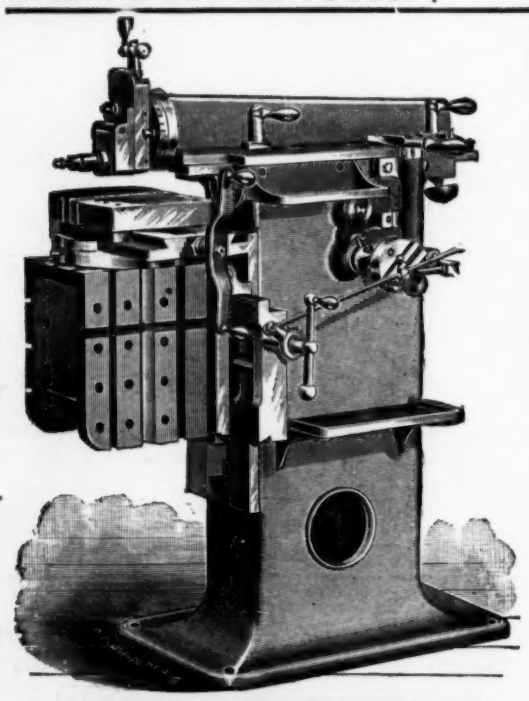

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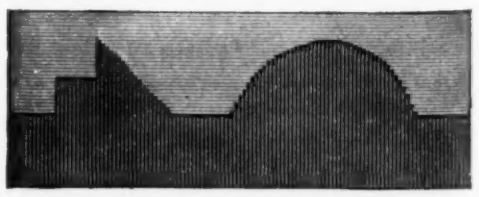

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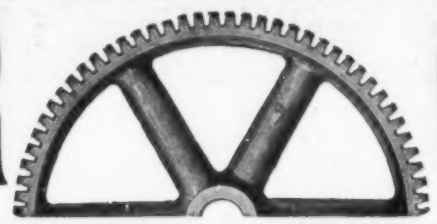

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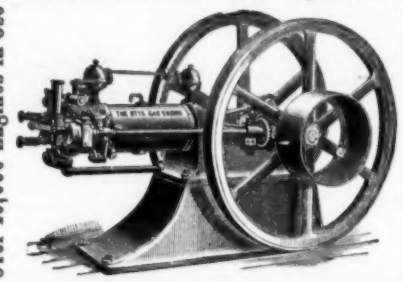

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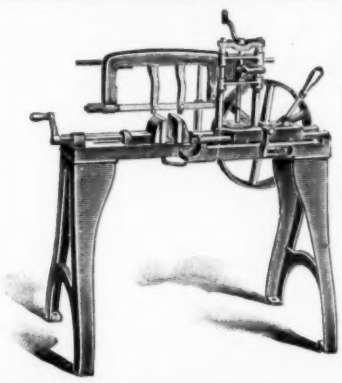

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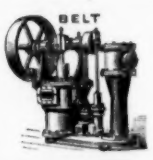

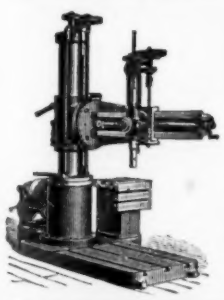

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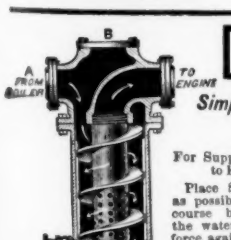

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Simpson's Centrifugal Steam Separator.

For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.

Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.

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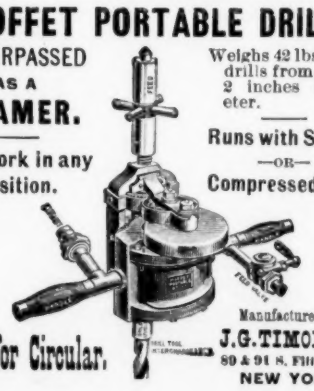

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Runs with Steam —OR— Compressed Air.
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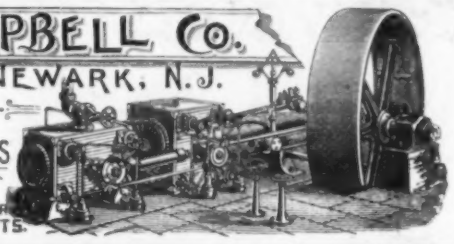

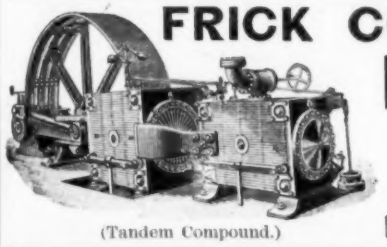

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40 TO 2,000 H. P., ALL STYLES.
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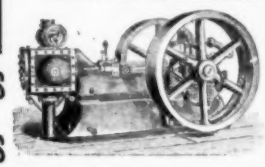

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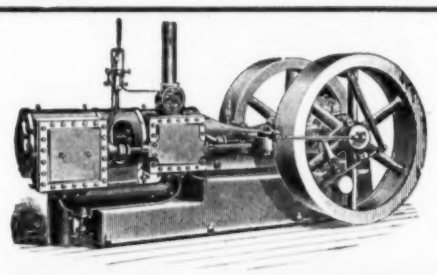

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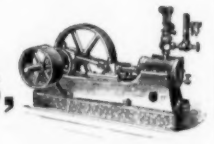

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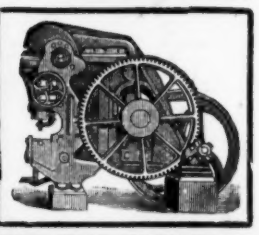

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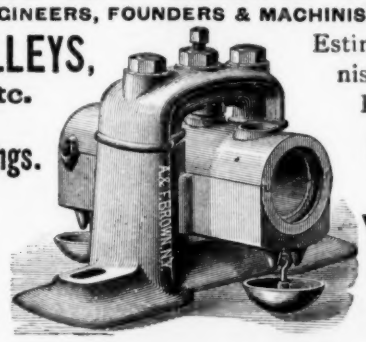

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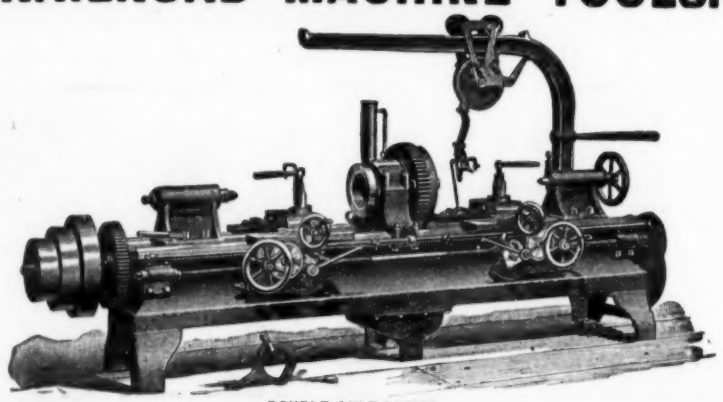

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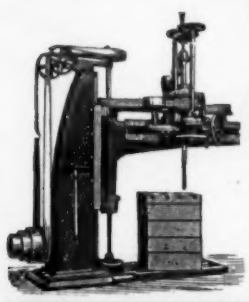

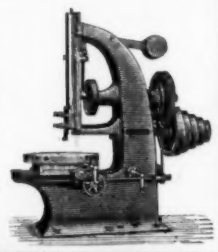

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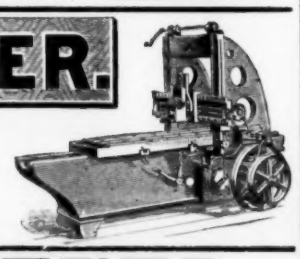
Send for list containing
Over 100 SIZES and lengths, with illustrations.



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Having made some changes in the sizes of our **Screw Machines**, we will sell all our stock of 1891 model No. 3 machines at 10% better discount than our usual prices.

FOR IMMEDIATE DELIVERY WE OFFER:

2 No. 3 screw machines, with geared friction head, and 1 11-16 in hollow spindle.
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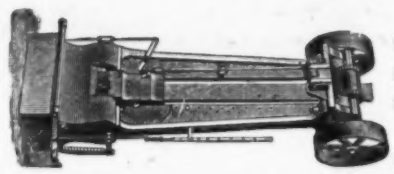

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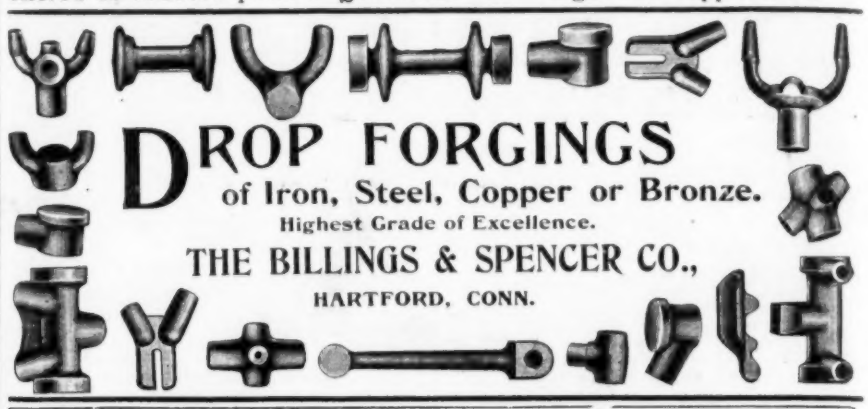

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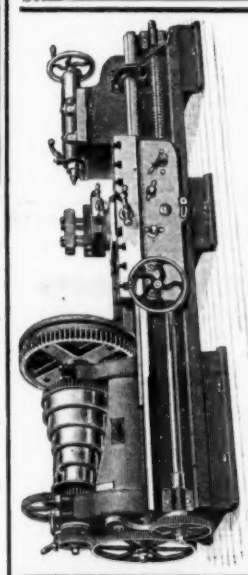
SEND FOR CATALOGUE AND PRICES.



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from 17 to 50 in. swing. Cuts, Photographs and Prices furnished on application.
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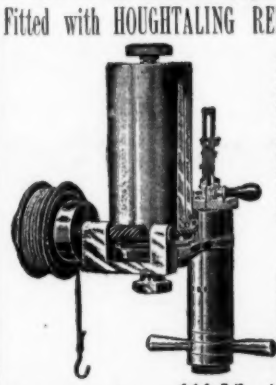
The Tabor Steam Engine Indicator,
Fitted with HOUGHTALING REDUCING MOTION.



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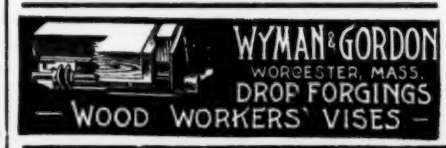

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